DECEMBER 1961
Vol. 80, No. 12

ELECTRICAL ENGINEERING

Published by American Institute of Electrical Engineers

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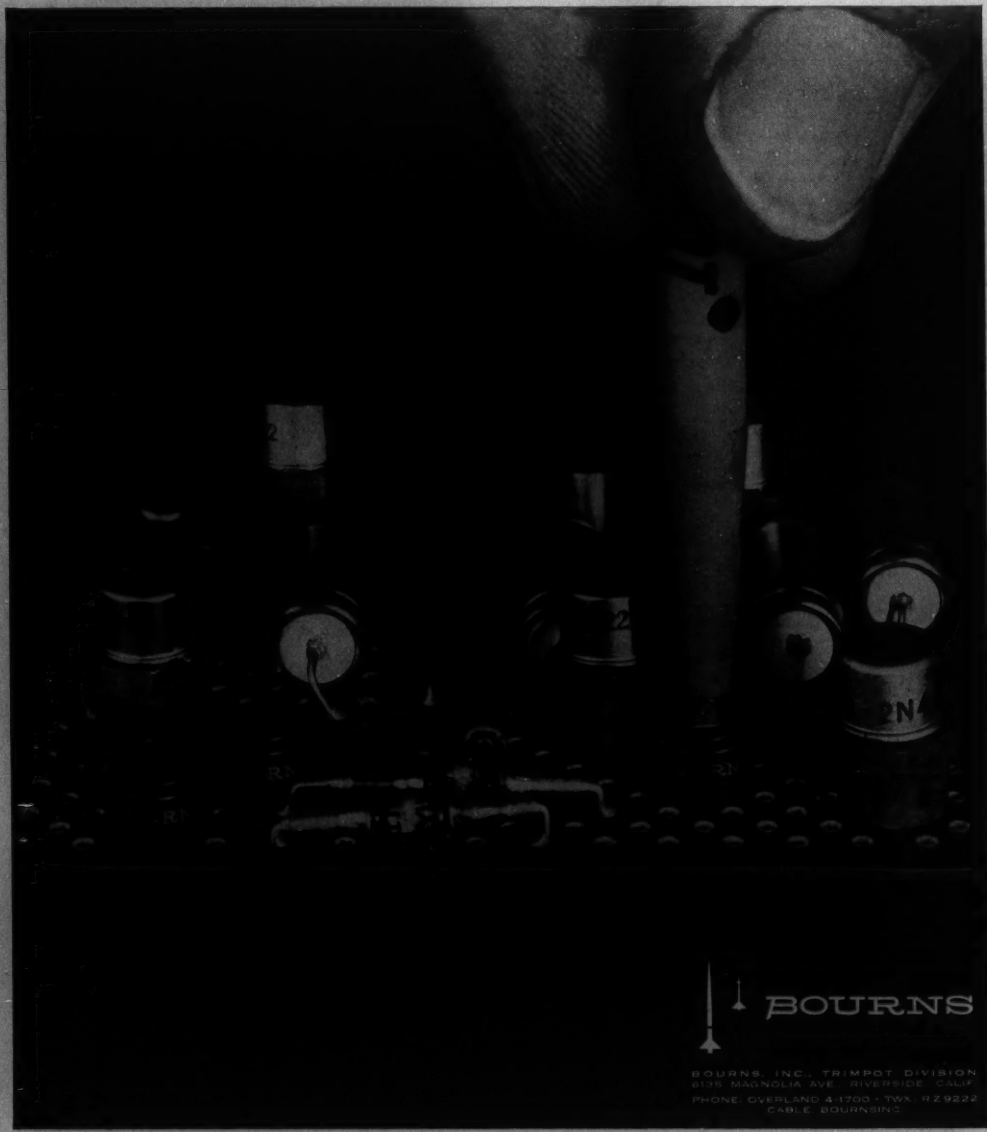

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ELECTRICAL ENGINEERING

Published by American Institute of Electrical Engineers

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THE COVER
Giant wafer coils designed by Sylvania generate microwave beams strong enough to reach the moon. Coils range in size up to 42 inches in diameter.
Story on page 983

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AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

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MONEL Alloy 404 . . . a new nonmagnetic alloy that can be multiple brazed in wet hydrogen

During multiple brazing operations, furnace atmospheres must contain enough water vapor to prevent the brazing alloy from wetting the fixtures. Yet the parts to be brazed must remain wettable to insure free flow, even after two or three trips through the furnace.

MONEL* Alloy 404 is a nickel-copper composition in which residual elements are held to low levels, to provide a clean, wettable surface to the brazing alloy even after continued exposure to wet hydrogen. And it retains the basic properties of MONEL Alloy 400 . . . low vapor pressure, strength, ductility, corrosion resistance.

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The low magnetic permeability of MONEL Alloy 404 is not significantly affected by processing and fabrication, making it particularly suited for electronic parts. In any commercial form, size, or temper the permeability will not exceed a value of 1.1 at 27°F when measured using a field strength of 0.5 oersted. A nominal or typical value is about 1.01 at 27°F. (1.004 at room temperature using a field strength of 200 oersteds).

The thermal expansion of MONEL Alloy 404 is about the same as that of MONEL Alloy 400, and is sufficiently close to that of many other alloys frequently used in the construction of radio tubes to permit the firing of composite metal structures with a negligible amount of distortion. MONEL Alloy 404 also retains much of its strength at "out-gassing" temperatures.

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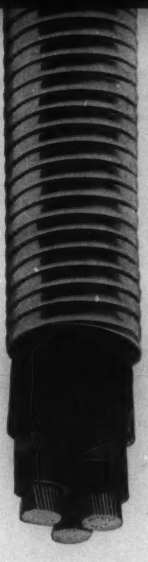

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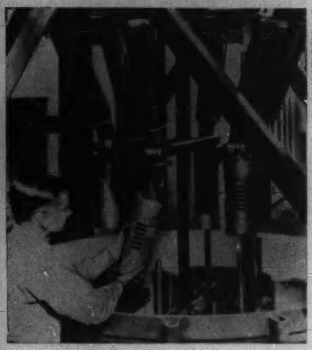
NEW/IMPROVED PRODUCTS

Oil Circuit Breaker . . .

Lower installation costs and substantial maintenance savings over conventional 3-tank breakers of the same rating are claimed for a new single-tank 69-kv



subtransmission oil circuit breaker. The new unit is said to be the U. S. electrical industry's first unit of its type. It is an extension of the company's line of single-tank breakers in subtransmission ratings. The new breaker fulfills all standard rating requirements. The new design incorporates the Kool-Arc vertical interrupter for safe and efficient 3-phase interruption in one tank. *I-T-E Circuit Breaker Co., Power Circuit Breaker Div., 1667 N. Main St., Los Angeles 12, Calif.*

Rigid Conduit . . .

Rigid PVC conduit for electrical raceways, just introduced, is made from 100-per-cent virgin polyvinyl chloride. The material is nonconductive and not affected by corrosion, rust, or electrolysis. It is listed by Underwriters' Laboratories, Inc., for direct underground burial or encasement in concrete. It is furnished in standard 10-foot lengths with one coupling installed on each length. Standard sizes from 1/2 inch to 6 inches in diameter are offered. *Lasco Industries, 1561 Chapin Rd., Montebello, Calif.*

Static Inverter . . .

Specifically designed for flame safeguard control equipment in power installations of utility power companies, this new solid-state static inverter has already been furnished to Southern California Edison Company to operate Bailey Meter Company equipment. The unit operates from a battery voltage of 105 to 140 volts d-c and delivers 130 va at 115 volts a-c, 60 cps. Output voltage regulation is ±10 per cent for an input variation from 105 to 140 volts d-c and load variation from zero to full load. Frequency is held to ±10 per cent. Ambient temperature range is 32 to 122 F. *Dynage Inc., 390 Capitol Ave., Hartford, Conn.*

Tap Connectors . . .

Cable can be connected to aluminum or copper buses, spades or contact pads of transformers, switches, or switchgear enclosures with a new line of tap connectors. Types LS and LSN single-tap and LD 1-way or 2-way eyebolt tap connectors cover the full range of cable sizes from no. 10 solid through 2,000 MCM cable. They permit clamping up through a 3/4-inch-thick pad or structural member. *Penn-Union Electric Corp., Erie, Pa.*

Wiring Raceway . . .

Wires can be inserted through the top of a channel wall when a new style of wiring raceway is used. The raceway prevents the wires from springing out of position before connections are made. Designated

as Panel Chanel style series VN, the raceway has wire slots with contoured top openings, through which wires can be slipped in place. The openings are shaped to hold the wires in position after insertion. Surfaces are rounded so that wires can be inserted without damage to the insulation. The raceway is molded of a thermosetting plastic as is available in black, grey, or white in a full range of sizes. *Stahlin Brothers, Inc., 365 Maple St., Belding, Mich.*

Fractional Horsepower Motors . . .

A new line of a-c and d-c fractional hp motors of sizes 12 and 15 is now available. D-c motors can be obtained in a variety of types including permanent-magnet as well as series or shunt. The a-c units are available in all types. Motors may be supplied with optional brakes, noise filters, thermal overloads, gear boxes, and other accessories. *Transco Products, Inc., 12210 Nebraska Ave., Los Angeles 25, Calif.*

Storage Capacitors . . .

Cartwheel construction techniques are used for a new line of high-energy storage capacitors. This technique incorporates fabrication methods which minimize self-inductance and reduce series resistance to an insignificant value. The Hi-Pak capacitors can be completely discharged in as little as 0.1 microsecond. *Dearborn Electronic Laboratories, Inc., P. O. Box 3431, Orlando, Fla.*

Three-Phase Protector . . .

Personnel, motors, and machinery are protected against 3-phase voltage unbalanced, phase failure, or phase reversal when a new protecting device is used. The static, transistorized unit operates from voltage signals. Called PhaseGuard, the new device can be used on either delta or Y 3- and 4-wire systems. It monitors the 3-phase voltage circuits for both magnitude and phase relationship. Operating time is 30 to 52 milliseconds. *Emerson Electric Mfg. Co., 8100 Florissant Ave., St. Louis 36, Mo.*

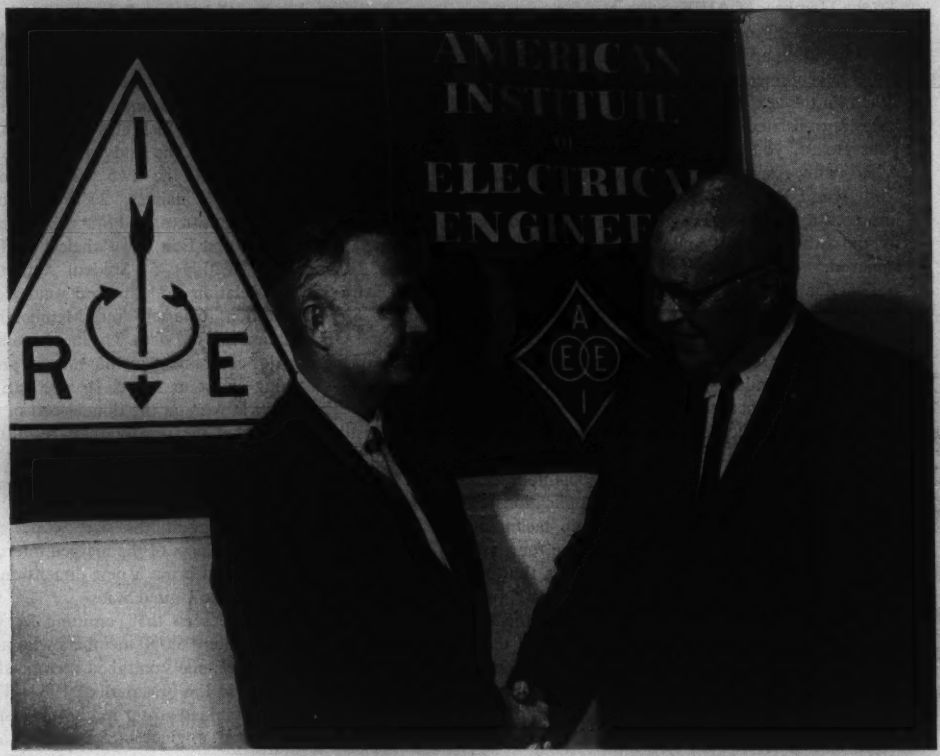
Furnace Seal . . .

A new terminal seal for high-temperature electric furnaces has been developed. Ordinarily, electric furnaces with silicon-carbide resistors have sealed box-type enclosures to cover the terminal ends of the heating elements that project from each side of the furnace. The new seal eliminates the seal box-type enclosure. As a result, the furnace shell temperature is reduced, maintenance simplified, explo-

sion hazard eliminated, and other benefits realized. The new atmosphere termi-

(*Continued on page 18A*)

AIEE and IRE Boards move toward consolidation



"Only one kind of electron, one spectrum; Why Two Institutes?"

President Warren H. Chase of AIEE and President-Elect Patrick E. Haggerty, Jr., of IRE at the AIEE Fall General Meeting in Detroit discuss plans looking toward consolidation of the two Institutes. Dr. Haggerty reported to the AIEE Board on October 20 that the IRE Board had two days before unanimously approved a resolution to proceed with merger studies. The AIEE Board also approved unanimously. The Resolution calls for the formulation of specific proposals on which each Board and the membership of each society must take action as required by their constitutions and charters. The Resolution as approved by the Board of AIEE follows. For President Chase's message on the subject, turn the page.

Merger Discussions Open Opportunities and Challenges

President W. H. Chase says in the following message:

To the Members of AIEE:

I hope each of you will read and carefully consider the Resolution approved by your Board of Directors at its recent meeting and printed on these pages. When, in the next few months, the objective it establishes is translated into concrete plans satisfactory to your Board, you will make the final decision for AIEE with respect to the proposed consolidafion with IRE. I hope that decision will be based on an informed appraisal of the purposes held in common by the two Institutes and how best they may be achieved.

That the purposes of AIEE and IRE are essentially the same is revealed not alone by the words in their Constitutions, but more convincingly by the extent of their collaboration in student branches, conferences, standards, membership exchange, section activities, education studies and curriculum accreditation, and other less formal but important professional work. This collaboration has developed from a growing appreciation of the common scientific basis for the wide variety of applications encompassed by electrical and electronic technology and from an inherent engineering distaste for wasteful duplications of effort and expense. As the technological interests of the members of the two Institutes overlap more and more, the management of this collaboration becomes more complex. It, therefore, appears that the time has arrived to make the effort to complete an organizational unity that will, to the greatest degree, match, promote, and serve the growing technological unity.

The complete design and construction of a single new organization embodying the best features and traditions of the present two Institutes with flexibility to serve a rapidly growing profession, is a problem of huge dimensions and exciting challenges. I will say more about these dimensions and challenges; but first, a word about the way the design is being developed.

DESIGN FOR MERGER

Good design starts with the recognition of a need and a concept of how to meet it. As long ago as June 1956, the AIEE Board of Directors recorded by formal vote its desire ". . . . to work toward the ultimate goal of merger with IRE." Subsequent discussions, formal and informal, between the officers of the two Institutes led to extensive areas of collaboration and ultimately arrived at the conclusion that the logical culmination appeared to be consolidation.

A design for consolidation will be prepared and brought to the two Boards in February. If approved, it will be put before you, the members, for a ballot in the spring. In addition to the joint committee named in the Resolution, subcommittees of present and past officers of the two Institutes will formulate plans for the consolidation. The study will include the following components of the two organizations: 1) Assets, Resources, Finances; 2) Professional Groups, Technical Committees, and Standards Activities; 3) Publications and Editorial Policies; 4) Districts, Regions, and Sections; 5) Student Activities; 6) Extra-Society Relations; 7) International Relations; 8) Constitution, Charter, and Membership; 9) Staff Organization and Services. The mere enumeration of these major components of the merger problem says something about its scope. Its size can be appreciated only by looking at the dimensions of the two Institutes and what the sum of their resources, membership, and activities can mean.

DIMENSIONS OF MERGER

From virtually any viewpoint, the size, scope, and combined potential usefulness of the merged interests of AIEE with IRE would bring a new dimension to engineering societies in the United States.

In Table I it will be seen that, omitting 28,347 students and approximately 6,000 members who now belong to both societies, the combined membership was close to 121,000 in the first part of 1961. This is greater than the combined roster of the civil, mechanical, and chemical engineering societies, and would make the new engineering Institute by far the largest in the world.

The combined assets of the two societies, according to the latest published reports, were $6,497,415.

Table I: Comparative Total Membership by Grades

Grades		Number of Members		
AIEE	IRE	AIEE	IRE	TOTALS
Honorary Member	—	9	—	9
Fellow	Fellow	1,694	896	2,590
Member	Senior Member	16,126	10,001	26,127
Associate Member	Member	36,690	47,114	83,804
TOTAL VOTING MEMBERS		54,519	58,011	112,530
Affiliate	Associate	1,994	12,806	14,800
	SUB-TOTALS	56,513	70,817	127,330†
	Students	10,685	17,662	28,347
	TOTALS	67,198	88,479*	155,677

* 90,577 as of August 31, 1961

† Approximately 6,000 members belong to both Societies.

Sources: AIEE: Organization Manual 1961-1962; figures as of April 30, 1961
IRE: Report of the Secretary, 1960; figures as of Dec. 31, 1960

THE RESOLUTION

Approved by the Board of Directors of IRE October 18, 1961
Approved by the Board of Directors of AIEE October 20, 1961

Whereas the Board of Directors of the American Institute of Electrical Engineers and the Board of Directors of the Institute of Radio Engineers have concluded that the advancement of the theory and practice of electrical and radio engineering and the educational and scientific objectives of both Institutes may be better served by merger or consolidation of the two Institutes into one organization in which all present members would be included, and in which they would enjoy the same rights and privileges now conferred upon them by their separate organizations, and it appearing that such consolidation would not adversely affect the Institutes or their members, now therefore be it

RESOLVED, that the Board of Directors of AIEE deems it advisable in accordance with the stated objectives of AIEE, to move actively toward the consolidation of the activities and organization of AIEE with those of the Institute of Radio Engineers (IRE), by consolidation or otherwise, provided that the legal and operational problems incident to such consolidation can satisfactorily be resolved, and

FURTHER RESOLVED, that Warren H. Chase, Clarence H. Linder, Elgin B. Robertson, and B. Richard Teare, Jr., be and they hereby are appointed to join with Lloyd V. Berkner, Patrick E. Haggerty, Ronald L. McFarlan, and Haraden Pratt, when appointed by the Board of Directors of IRE, as members of a committee, which shall be authorized and directed to undertake such studies as they shall deem necessary and appropriate to determine the feasibility, practicability and form of such consolidation, and to make a report thereon to the Boards of the two Institutes not later than February 15, 1962, with a view to submission to a vote of the memberships of the two Institutes and consummation, if so approved, by January 1, 1963, and

FURTHER RESOLVED, that such committee shall be authorized to meet with the officers, directors and representatives of the two Institutes to consider the proposed amalgamation of the two groups and to make available to such persons such documents and information relating to AIEE as such committee deems advisable under the circumstances, and

FURTHER RESOLVED, that this committee be directed to prepare, in consultation with representatives of AIEE and IRE, a proposed Constitution and Bylaws and such other documents as counsel may recommend with a view to submission thereof to the Boards of Directors of the two Institutes on or before February 15, 1962, and

FURTHER RESOLVED, that the proper officers and directors of the AIEE be and hereby are authorized and directed to cause a copy of these resolutions to be delivered to the Board of Directors of the Institute of Radio Engineers, and

FURTHER RESOLVED, that these resolutions shall become effective as soon as the President of the American Institute of Electrical Engineers has been notified in a form satisfactory to him and to counsel of the AIEE that the Board of Directors of the Institute of Radio Engineers has adopted resolutions substantially to the effect of these presents.

IRE carries in its assets a figure for its three buildings, land, furniture and fixtures at cost, at Fifth Avenue and East 79th Street, New York, of $1,549,751. AIEE is housed in the new $12½ million, 20-story United Engineering Center, New York. AIEE has a headquarters staff of about 100; IRE, 175.

The latest year's combined total income was $5,659,008; combined total expenses, $5,273,743. Both societies operate "in the black."

Recent annual publication figures are as follows: AIEE: *Electrical Engineering*, editorial 1,108 pages, advertising 756 pages; Transactions-Bimonthlies, 2,807 editorial pages only. Additionally, AIEE preprinted 10,600 pages of authors' manuscripts, plus more elaborate publication of 13 sets of papers and reports, 1,672 pages; and a 10-year Cumulative Index, 400 pages; Grand Totals: editorial 16,587; advertising 756. IRE: *Proceedings of the IRE*, editorial text 2,325 pages, advertising, 2,485 pages; PG Transactions, 8,616 pages; Convention Records, 3,396 pages; with Student Quarterly, Directory, etc.; Grand Totals: editorial, 15,338; advertising 3,272.

Table II:

	Attendance	Days	Sessions	Papers
AIEE — General Meetings				
Winter, New York	5,000	5	110	500
Summer, movable	2,000	5	65	270
Pacific	700	4	20	70
Fall, Mid-West	1,800	5	50	200
SUB-TOTALS	9,500	19	245	1,040
— District Meetings (4)				
Combined figures	2,200	8	74	285
TOTALS, GMs-DMs	11,700	27	319	1,325
IRE — Convention, New York	67,419*	4	54	257
Wescon, California	35,000*	4	40	158
TOTALS	102,419	8	94	415

* Including Exposition attendance

AIEE obtains its papers through the operations of 67 Technical Committees and 214 Subcommittees covering that many phases of electrical-electronic interest, but some subjects such as radio in less detail than IRE. These 67 Technical Committees also control the papers review and classification-for-publication machinery; and do standards work for AIEE and ASA Sectional Committees.

IRE performs papers procurement, and placement in Convention sessions and Symposia, through the Professional Groups' organizations. Review of papers is accomplished by reference to selected individuals on a large roster of Editorial Reviewers appointed for the purpose.

AIEE holds four General Meetings and an average of four District Meetings, in eight different U.S.-Canadian cities annually. IRE holds its International IRE Convention and Show annually in New York, and participates in the annual Wescon Electronic Show and Convention with movable San Francisco-Los Angeles location. Data on typical recent meetings are shown in Table II.

Both societies encourage and hold related exhibits in connection with their sole and joint conferences, largest of which is through joint sponsorship of the National Electronics Conference in Chicago. AIEE in 1962 will hold its first exposition in connection with a General Meeting, but IRE has a long history of successful shows in connection with its annual International IRE Convention at New York and more recently with the IRE Wescon Convention in San Francisco-Los Angeles. The 1961 Show brought together 850 exhibitors, 25,000 items, and 67,000 visitors, at over two miles of booths.

AIEE holds at annual, biennial, or irregular intervals 53 Special Technical Conferences, of which 20 are exclusively AIEE-sponsored and 20 are jointly sponsored with IRE; 27 institutions appear also as co-sponsors in 33 conferences. It will be noted that AIEE-IRE integration in the field of conferences has not awaited merger: IRE held or participated in 59 conferences or symposia in 1960, including four in Europe.

IRE participation in symposia is a prerogative of nationally organized Professional Groups (PG's) of which there are 28. An IRE member may belong to as many Professional Groups as he chooses. Thus there are 89,114 memberships (including 6,729 students) in the 28 PG's. PG fees vary from $1.00 to $6.00 per year. Under the affiliate plan, 500 scientists and medical doctors belong to PG's in their specialties.

In their foreign operations, both societies integrate Canada with the United States. Apart from Canada, AIEE has 2,424 foreign members, IRE 2,728. IRE has 11 Sections in South America, Europe, Asia, and Africa; AIEE none. Both Institutes have reciprocity arrangements with British societies. Both are active in the work of the International Electrotechnical Commission and other international standardization and scientific bodies, IRE to a greater degree than AIEE. Except for Section operations, and liaison with outside organizations in Canada, the foreign contacts of the integration would be chiefly additive.

Both IRE and AIEE, have a thoroughly organized Section, Subsection, Branch, and District organization. The corresponding numbers are shown in Table III.

Table III:

	AIEE	IRE
Districts — Regions	15	8
Number of Sections	119	110
Number of Subsections	77	31
Number of Student Branches	167	211
Number of Professional Groups	—	28
Number of Section Technical Discussion Groups	277	—
Number of P/G Chapters	—	288

Sources: AIEE: Annual Report, 1960-1961
IRE: Proceedings of the IRE, September 1961

Of AIEE's 167 and IRE's 211 Student Branches, 127 are already jointly operated; the others are independent. But in only 24 schools do the tasks of the AIEE Counselor and the IRE Representative reside in the same faculty member. Merger would erase anomalies introduced by dual representation.

A recognized overlapping in the field of standards activities was coped with a year ago by the formation of the Joint Standards Committee of AIEE-IRE. In AIEE 55 Technical Committees engage in standards work. The Standards Committee makes AIEE appointments to 78 ASA Sectional Committees and to 5 ASA Standards Boards. IRE has 26 Technical Committees which with their 120 Subcommittees and task groups, carry on the standards work. IRE is directly represented on 34 Sectional Committees of ASA and sponsors 3 of them. Both societies prepare non-overlapping standards, AIEE chiefly in the field of power and its applications, IRE in radio.

CHALLENGES OF MERGER

The prime opportunity of merger is to create from the components of the two societies a new association with a usefulness, to its combined membership, greater than the sum of its parts.

Since the services rendered to the public by member engineers are directed through the electrical and electronic industries they serve, these industries should be well served by the contemplated merger; and their continued support warranted by the steps taken by members to unify and concentrate their efforts. No longer would it be necessary for industry to weigh the merits of electrical vs. electronic claimants. Amalgamation would be a living symbol of the unity of electrical-electronic engineers, and represent the clearing away of artificial barriers between the manufacture and distribution of electrical power and its end uses, in quantities great and small, in frequencies low and high.

Welcome adjustments on the campus would presumably follow the cessation of the lively competition which has existed between AIEE and IRE Student members. The flow of undergraduates and graduates into the appropriate Institute grades would be far smoother than heretofore. With the advent of unity, the tie-in between universities and the amalgamated society ought to be less inhibited, more productive. In areas of research, exchange of technical knowledge, and establishment of optimum curricula, the one consolidated Institute should be more helpful.

By merger both components would pool the strength of their philosophies regarding the integration of science and engineering. Services rendered by engineers to scientists, and in the reverse, bring mutual and collateral public benefits. Such integration is a "must" in an atomic age.

By merger AIEE members would stand to benefit from IRE's astuteness in establishing identifiable activities and sizable membership overseas. Electrical Power components of the consolidation will receive increased challenge to international endeavor heretofore existent and significant but by comparison restricted.

As one of the Founder Societies, AIEE would bring to the new Institute a status in the community of engineering heretofore missing in the IRE program. The achievement by merger of unity in electrical-electronic engineering should immeasurably strengthen the leadership hitherto assumed by AIEE in establishing a pattern for unity of the entire engineering profession. It is thought that effort salvaged through synthesizing the separate administrative duties of the present Boards of Directors, headquarters staffs, and committees working on similar affairs in the two societies can profitably be channeled into broader programs which will strongly promote engineering as a profession.

Section and Subsection operations already include considerable AIEE-IRE joint activities. Adjustments would have to be made to insure that the Section served the needs of the combined power and electronic components of the spectrum of electrical interests. The same may be said for the co-ordination of the local Technical Discussion Groups and the Professional Group Chapters; in IRE these are affiliated with the Institute-wide Professional Groups; in AIEE these are not so affiliated although a current movement in establishing Institute Technical Groups contemplates local chapters.

Publications of the two societies are their principal items of expense, advertising in them an important source of revenue, and their distribution to all members and groups of members the major service commanding membership. The determination of the character and distribution of a merger Institute's publications is therefore one requiring great wisdom in planning. Not only is wider coverage of the professional field involved, but the mechanics of publication should ideally afford individual members a means of individual selection of desired material.

If and as the societies merge their histories along with their plans, member engineers will take pride in the past public achievements and benefits of their new confreres. Representative of both societies are frequently consulted by Government. IRE members have made many contributions to the safety of life at sea, and have helped the government bring order to a chaotic and hard-pressed radio spectrum. AIEE members have made constant contributions to safety from fire and resuscitation of life after shock, and to the mitigation of air pollution in our industrial cities. A long list of awards made by both parties testifies to the public benefactions of their respective members. The preservation and wise adaptation of the systems of awards would be a welcome responsibility assumed by the consolidation.

In planning the in-phasing of the two societies, attention must be given to the differences in termi-

nology to avoid misunderstandings. The application of "Member" and "Associate" to different corresponding grades of membership is a case in point:

GRADE	AIEE	IRE
Honorary	Honorary Members	—
I	Fellows	Fellows
II	Members	Senior Members
III	Associate Members	Members
IV	Affiliates	Associates
V	Student Members	Students

Another difference is in the names of publications. AIEE's primary reference annual bound publication is its *Transactions;* IRE's is its *Proceedings*. AIEE produces three bimonthly magazines containing prepublication of annual *Transactions* articles. IRE refers to the periodicals issued by its Professional Groups as its *Transactions*. AIEE's general circulation monthly and secondary reference bound annual is *Electrical Engineering;* IRE's *Proceedings* is both its general circulation monthly and primary bound annual.

In AIEE, Technical Committees concern themselves principally with papers procurement, review and classification, and placement in meeting sessions. In IRE, Technical Committees are primarily engaged in Standards work.

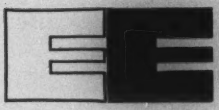
In AIEE, the name Institute Technical Groups (ITG's) has been chosen to designate a new activity which in IRE has been the well-established system of Professional Groups (PG's).

AIEE members surveying the IRE membership constituency will perhaps be interested in the background resulting in the broad nonvoting, subprofessional stratum of 12,806 Associates in IRE, compared with the 1,994 Affiliates in AIEE. The reason is partly historical, because radio first brought to amateurism the technical complexities which rendered engineering information intelligible and useful to younger laymen. It was found by experience that a reasonably broad base of subprofessionals did the society no professional harm; that their youth contributed an enthusiastic reception of the unfolding radio and electronic arts; that many Associates, over the years, qualified for the higher grades by the same standards of professional experience applied to non-college graduates by the Founder Societies, and that as more complex radio-electronics (such as television, radar) became widely applied to daily living and the military, amateurs were supplemented by technicians in the Associate grade in construction, installation, maintenance, repair; as draftsmen, laboratory assistants, and engineering sales people. Traditionally, AIEE has not followed a similar philosophy in terms of electricians, contractors, maintenance forces and laboratory and field technicians, as power application and controls have become equally complex and widespread, as is evident from the figures. A similar situation exists in relation to the chartering of Student Branches. Among the IRE's 211 Branches are a number located at other than recognized degree-granting institutions. These divergent philosophies may require reconciliation in a merged operation.

However, I would like to make it very clear that the Joint Committee created by the Resolution and its subcommittees are not in any way engaged in, nor intended to engage in, bargaining for the ascendency of any point of view or the interests of any group. We should all appreciate this chance, seldom given to mature men or organizations, to make a fresh start and meet opportunities seemingly past and lost. I am confident we have the wisdom and statesmanship to carry the job through. If successful, it will have a profound effect on the whole engineering profession. It is a step worthy of the careful consideration and thoughtful expression of the opinion of every member of AIEE. I hope that in the coming months you will discuss it in your Sections and Committees and let me have your opinions both individually and collectively. And that, when the time comes, each member will cast an informed and considered ballot.

Cordially yours,
W. H. CHASE, *President*

Trends...as seen by



The impact of microelectronics on the electronics development laboratory will be most dramatic, according to R. F. Redemske, Servomechanisms, Inc. VP. Highly automated vacuum equipment operating in air-conditioned rooms will turn out quantities of evaporated thin film devices in considerably less space than now occupied by electronics plants.

The National Electrical Manufacturers Association is moving *into the industrial electronics field and is placing the highest priority on bringing into NEMA those companies with products still in the research and development field.*

Westinghouse Electric International Co. announces that it will participate with two Spanish companies in supplying electrical apparatus under a manufacturing program which will add 262,500 kw to the power capacity of southern Spain and Mallorca by 1966.

The day when man and machine can communicate intellectually *is not far off, according to Dr. Simon Ramo, of Thompson Ramo Wooldridge, Inc. He describes the new language in terms of color, sound patterns, finger snaps or taps, or the replacement of the decimal system by the binary or octal number system.*

Contracts for about $12.5 million have been awarded to Autonetics from International Business Machines Corp. for terrain-avoidance computers, test controls, and auxiliary equipment in connection with the Air Force's B-52 bomber modernization program. These computers work with radar and permit pilots to avoid objects that might jut up into the plane's flight path at low altitudes.

Trans World Airlines *has ordered the industry's first intercontinental reservations system to function through high-speed computers and data processors. The new system, Teleflite, is a product of the Teleregister Corp.*

The Sperry Gyroscope Co. and the Naval Ordnance Laboratory have developed an underwater detection system for submarines that can detect a target without revealing its own position. Moreover, a submarine now can compute range and bearing data on its target and automatically feed such data to a fire-control system which directs torpedo launchings against the target.

"I have no reservation on predicting that electrical manufacturers *will soon be building 'exotic' power plants for space just as routinely as they build conventional plants for land-based installation," said Dr. J. A. Hutcheson, Westinghouse Engineering Corp. He also said that with the present pace of space research, we could have a system generating power on the moon before we have one operating full time on a power company's lines.*

A marriage between Reliance Electric and Engineering Company and Schindler and Company, Ltd., resulting in a new company, Schindler-Reliance Electronics Ltd., and the building of a new plant in Dierikon, Lucerne, Switzerland, was announced by W. R. Hough, Vice-President of Research Development and Engineering. The partnership will result in a mutual exchange of gains in research, product development, and sales in the field of industrial electronics and engineered drive systems for the world's markets, and especially the markets in the economic unions of Europe.

Increased reliance upon standards *and standardization programs to offset the cost–profit squeeze is reported by 67 companies responding to an American Standards Association questionnaire. All reporting firms said their standards activities had contributed greatly to reducing costs.*

The Air Force has awarded Arma Division, American Bosch Arma Corp., an incentive contract valued at $17.6 million for additional inertial guidance systems for the ATLAS ICBM. The Arma system has proved its accuracy on test flights of ATLAS, the record being highlighted by two successful 9,000-mile flights from Cape Canaveral into the Indian Ocean.

Research spending in the U.S. *will amount to about $16 billion in 1962, according to G. W. James of Battelle Institute. He estimates that the Government will spend about $10 billion; industry about $5.5 billion, and universities and foundations about $350 million.*

The first electronic data-processing system in South Asia has been established in India by Standard Vacuum Oil Co. in its Bombay office, where it will supersede electric accounting machines in handling a growing volume of record keeping and statistical analysis.

Reviewed by AIEE Technical Committees

Engineering Progress—1961

Year-end progress reports from AIEE technical committees covering the six broad fields of engineering activity—communication, general applications, industry, instrumentation, power, and science and electronics—underscore what has become one of the chief characteristics of our time: an ever quickening pace of technological development coincident with the dissolution of traditional boundaries separating the fields of adjacent engineering disciplines.

In communication, the Bell System introduced into commercial use substantial quantities of equipment providing the Centrex features of PBX operation. A space division system was demonstrated by the Bell System with the successful field trial application of electronic switching at Morris, Ill., during the past year; also a full-featured electronic space division PABX was announced and demonstrated by Automatic Electric Laboratories. Commercially economic feasibility, however, is yet to be demonstrated.

Work on the theory of noise, detection, and continuous systems continued at a high rate. Notable were a theoretical study of diversity reception and reported progress in linking the areas of signal design and error-correcting codes. During the year, significant advance in data transmission was made in the general availability of wide-band facilities. This has already stimulated the development of high-speed data subsets. In the area of radio communication systems, the second site of the Ballistic Missile Early Warning System (BMEWS) became operational during the year. The Clear Site in Alaska is now linked with the BMEWS Site I in Thule, Greenland. This link-up covers the northern polar wastelands, providing the United States with a 15-minute notice of an impending ICBM attack. And several developments of microwave, transistorized (except for an output klystron tube) radio communications equipment were completed during 1961. These meet rigid requirements for either television or telephone service at terminal and unattended relay stations. An example is the Lenkurt *76A* system. Quartz crystal oscillators with stability of one part in 10^{10} per day, or better, have been developed. In the field of space communication, 1961 was primarily a year of decisions affecting the future of satellite communication systems and of preparation for future experiments.

In the area of general applications, a significant advance in the techniques of squib and detonator ignition has been achieved in the development of EBW (exploding bridge wire). A miniaturized short-range transceiver is under development at the Norair Division of Northrop Corporation. New antenna information and near-field information has been obtained which makes a miniature low-frequency design possible. Signals received from the U. S. Navy's Transit satellite, launched June 29, 1961, were transmitted by the first atomic power source to be used in space, a radioisotope-fueled SNAP thermoelectric generator built for the AEC by The Martin Company. In marine transportation, the largest diesel a-c electric propulsion system ever built will go into service early in 1962. This 15,000-hp direct-drive synchronous-motor-propulsion system will drive the Navy's 18,000-ton submarine tender *AS-31*.

Progress in industry was recorded in the lowering of cement manufacturing costs by increasing use of automatic control techniques, increasing emphasis on modernizing facilities to use larger, more efficient, process work units. In feedback control systems, heavy emphasis was placed on those control systems in which automatic means are used to change the system parameters. In industrial control, an automatic gauge control system has been applied to a stainless steel continuous hot strip mill at the Midland plant of the Crucible Steel Company of America. A unique static power amplifier, with exceptionally high electrical and thermal efficiency, and incorporating the most desirable operating characteristics of conventional saturable core reactors and self-saturating magnetic amplifiers has been developed for a-c and d-c controlled power applications. The mining industry reports progress in the form of new products to enhance the safety, efficiency, and economy of mining operations.

Notable among many developments in the field of instrumentation was a redetermination of the National Bureau of Standards (NBS) unit of resistance by a new method based on a new theorem in electrostatics and its application to calculable standards of capacitance. The NBS has also developed a phase-angle master standard that is accurate to 0.01 degree at 400 cps. It is used to calibrate phase-angle meters and phase standards. Such devices are of increasing importance in missile guidance and other applications. In telemetering, the unsatisfied desire for higher degrees of accuracy in the transmission and accumulation of large amounts of data was largely responsible for the increased attention devoted to the use of digital techniques during the past year. Advances in these techniques were made in connection with flight-testing instrumentation involving air-to-ground transmission of information.

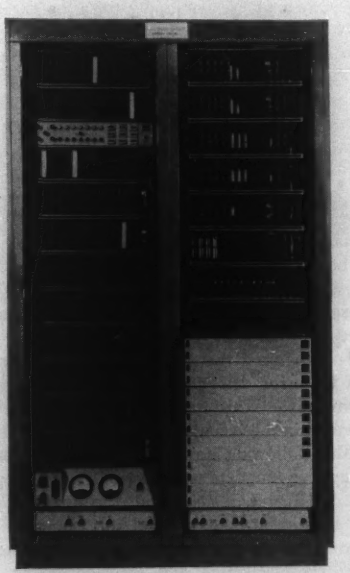
In the power field, the Cornell Extra-High-Voltage Cable Field Testing Project entered the actual cable-testing phase in April 1961. Four complete cable systems are under test. The Power Generation Committee reports that two large new generating stations were operating during the year by computer control: Huntington Beach of Southern California Edison and Little Gypsy of Louisiana Power and Light. The computer control systems at these plants accept approximately 1,000 analog and digital signals from the plant, and initiate a start-up or shutdown. Developments in communications for the power field are reported to have been largely related to transistorization of equipment and developments surrounding application to higher voltage transmission lines. In the field of rotating machinery, a tandem-compound turbine generator unit has been put in service at the Arkansas Power and Light Company. The first 2,500-hp synchronous motors equipped with brushless excitation systems have recently been manufactured by the General Electric Company. D-c excitation is supplied by the rotating armature of a small 3-phase a-c generator mounted on the motor shaft and wired directly through the silicon-control rectifiers to the motor field winding. The Substations Committee reports that substation insulation and electrical clearances required for voltages on the order of 500 kv and above were under study in many places during 1961. In switchgear, gas-filled circuit breakers utilizing sulfur hexafluoride as the interrupting medium were developed for the subtransmission voltage of 34.5, 46, and 69 kv. Transmission and distribution progress was reported for ehv projects in the United States and Canada. The newest line to be energized was the Apple Grove (West Virginia) project of American Electric Power, Westinghouse, and six other leading manufacturers.

Developments in science and electronics were notable. The fast-moving computer field continued to display a great variety of improvements during the past year. Parallel processing information, multiple input-output channels with facilities for real-time connections with remote points, hierarchies of memories with different speeds and novel ways of addressing them, plus faster units of peripheral equipment constitute the principal hardware features in this advance. Developments in electron tubes continue to reflect the emphasis placed on missiles, space exploration, and defense. Major efforts were made in 1961 to improve the reliability and performance of the tubes and associated components. Most interesting in the research field is the laser or optical maser. The laser is similar to the microwave maser but operates in the visible and infrared region of the electromagnetic spectrum. Two forms, gas and semiconductor (ruby) lasers have been reported. In electronic circuits and systems, digital computers have probably experienced more significant development than in any other area through a multiplicity of improvements in components and approaches. Magnetic thin-film memory and integrated semiconductor techniques make possible a marked reduction in size, weight, and power consumption, as well as increased reliability. Of major interest in the nucleonics field during the past year are developments in the application of nuclear power to space travel. Nuclear concepts for the generation of electric power in space through the use of small high-temperature reactors and direct conversion of heat or radiation from isotopes into electric energy are being intensively explored.

COMMUNICATION

Communication Switching Systems

The year 1961 was one of continuing development and the culmination of projects of long standing in the communication switching field. The Bell System introduced into commercial use substantial quantities of equipment providing the Centrex features of PBX operation. No. 5 crossbar installations have been made to provide central switching apparatus for use by many PBX customers. They offer the following service features: inward dialing, outward toll dialing



General Dynamics Telecommunication Division's time division electronic PBX

and attending operator services with the operator located on the customer's premises remote from the equipment. Efficiencies in equipment, floor-space saving, and reduction of maintenance effort are advantages significant to the telephone operating industry.

A space-division system was demonstrated in com-

mercial service with the successful field trial application of electronic switching at Morris, Ill., by the Bell System last year. This year the British General Post Office is readying a field trial of a time division multiplex (TDM) electronic switching system at Highgate Wood. A full-featured electronic space division PABX was announced and demonstrated by Automatic Electric Laboratories this year, with commercially economic feasibility yet to be demonstrated.

General Dynamics/Telecommunication has announced a time-division electronic PBX which is to be commercially available in 1962. This PEBX was shown at the USITA convention in October, 1961 and was cut into service by the United Telephone Company of the Carolinas at Southern Pines, N. C., also, in October, 1961.

Many switching equipment development teams are readying semielectronic switching systems to commercial use. These developments should reach fruition in the next 2 to 3 years.

Communication Theory

Work on the theory of noise, detection, and continuous systems is continuing at a high rate. Included among the most significant papers is a theoretical study of diversity reception.[1] A new class of band-limited functions useful in representing signals and having some remarkable properties has been studied.[2,3] A paper on Simplex codes reports progress in linking the areas of signal design and error-correcting codes.[4]

Important work on error-detecting and error-correcting codes includes some further generalizations of binary codes for nonbinary information.[5,6] There have been several important advances in the theory of Bose-Chaudhuri codes.[7,8] Some interesting codes for use with asymmetric channels have been described.[9,10]

It is recognized that cyclic binary codes are well suited for error detection and can be implemented economically.[11] This type of error-detection is incorporated in the recently developed IBM *1301* disk file. Also, following up the collection of error data on telephone-line data transmission systems reported at the AIEE-NEC (National Electronics Conference) session on data transmission last year,[12] several groups have determined the effectiveness of various error-detecting and error-correcting codes using these data. As a result of one such study,[13] Lincoln Laboratory is building a 2-way telephone-line data-transmission system using a cyclic code for error detection, in which the mean free time between undetected errors caused by channel noise will be in the order of 300 years.[14]

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Data Communications

One of the significant advances in data transmission in 1961 was the announcement of the general availability of wide-band facilities. This has already stimulated the development of high-speed data subsets and there will undoubtedly be rapid progress in this field in the near future.

Progress also continues in the utilization of voice-grade facilities with the announcement of a variety of new data subsets ranging from low-cost parallel-transmission types to frequency modulated (FM), phase-modulated (PM), and vestigial-sideband types capable of speeds up to 4,800 bits per second on voice-grade facilities.

A number of systems are now available for the transmission of punched paper tape at speeds up to 150 characters per second and magnetic tape at speeds up to 15,000 characters per second.

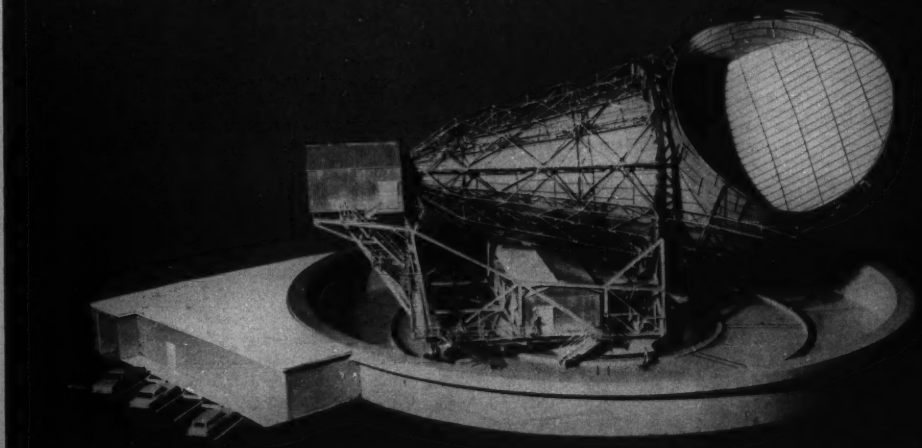
Additional information has been made available on the error characteristics of data transmission facilities. Also theoretical work continues on the development of more efficient and economical error detection and correction systems based on this new knowledge of error characteristics. Several experimental retransmission-type error-correcting systems have been built and reported upon.

Excellent progress has been made on the simulation of data subsets for evaluation of new modulation techniques without employing the time-consuming and expensive approach of constructing prototypes.

A system designed to provide relatively economical transmission of punched cards from a number of

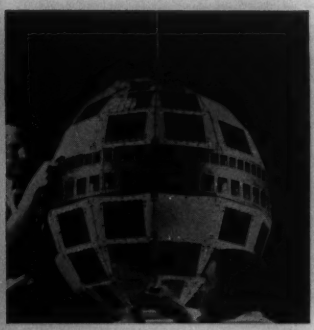
(Continued on page 951)

ENGINEERING DEVELOPMENTS



1961

Ever since 1948, *Electrical Engineering* has published an annual pictorial review of some of the interesting and significant engineering developments of the year. Through the years, it has become increasingly more difficult to keep pace with our exploding technology within the confines of a limited number of pages. As a result, even with the addition of more pages, a relatively small number of significant developments can be covered. This year is no exception. Once again we are indebted to those who answered our request for illustrations. We regret that we could not use all of them. We are especially grateful to Bell Telephone Laboratories for supplying the sketches used as illustrations on some of the following pages.



Illustrated above is a model of the "world's biggest horn" under construction at Rumford, Maine, by Bell Telephone Laboratories. The antenna, 177 feet long and housed in a radome (not shown) 210 feet across and 161 feet high will be used for experiments in sending television signals, high-speed data, and telephone calls across the Atlantic with the assistance of satellites. To the left is shown a developmental model of a Bell System active communications satellite for special radio measurements.

TRANSFORMERS

(1)

(2)

Two sections of a huge test transformer (1) were shipped to the Westinghouse power transformer plant now under construction at Muncie, Ind. When assembled, the 440-ton unit is about 16 feet wide, 34 feet long, and 42 feet high. It will be used to test power transformers with ratings in excess of 600 kv.

"Two transformers in one" is this Allis-Chalmers 16,600-kva rectifier unit (2) with both 3-phase Y- and 3-phase delta-connected primary windings assembled on one 6-phase core assembly. Double secondary windings give 12-phase output. More efficient use of core-steel clamping and terminal board connections resulted from this unique arrangement, with significant reduction in size and weight.

A 17,000-kva 115-kv mobile substation (3), shipped to Virginia Electric Power represents General Electric's millionth kva of mobile equipment. Significant advances made in 1961 by GE's Power Transformer Department have resulted in more kva per pound on the road.

Huge Allis-Chalmers 40,000-kva single-phase mobile power transformer (4) is shown prior to shipment by rail to the West Coast. The 94,000-pound transformer will be mounted on a special low-bed trailer for convenient transportation over highways in the utility's distribution area.

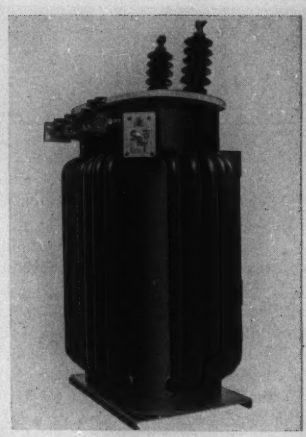
One of the most powerful generation station transformers in the world is this Allis-Chalmers unit (5), having an equivalent 2-winding capacity of 404,250 kva, which went into service in 1961 at Commonwealth Edison's Crawford Station in Chicago. This 3-phase unit's low-voltage winding is rated 385,000 kva at 12 kv. It has two 211,750-kva high-voltage windings, which will feed two 138-kv systems. The unit will be forced-oil cooled, with oil-to-air heat exchangers.

As a result of users' requests for larger-rated self-regulating distribution transformers, Line Material Industries has developed a 40-ampere tap changer (6). Rapid snap-action tap changes are assured through careful design of speed-controlling components. A shaded-pole motor, which rotates only when a tap change is required, loads a drive spring that snaps the moving contact from one position to the next. The entire tap-changer assembly operates silently under oil and is self-protected even if a tap change is made during a short circuit.

A new concept of residential distribution is being developed by Moloney Electric Company in co-operation with several utilities. This approach uses encapsulated distribu-

(3)

(4)



(6)

(5)

(7)

tion transformers instead of the present oil-filled transformers. Various applications of the transformer also are being developed jointly with the utilities. One example is a service transformer mounted on a house wall and fed from a subprimary-voltage underground cable (7).

A semiautomatic test booth (8) for performing complete commercial electrical tests on small and medium power transformers has been installed by Westinghouse at Sharon, Pa. The facility uses motor-operated devices, newly developed metering systems, and human engineering to consolidate the entire test system into one booth. Production testing time has been reduced to one third and the measurements are more accurate.

(8)

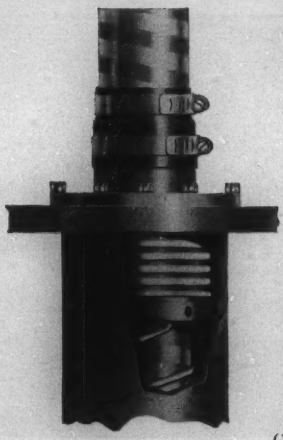
CABLE

High-permeability magnetic shielded cables for inertial guidance system of Titan missile are shown in ground support installation at Cape Canaveral (1). The three cables, ranging from 1.67 to 2.13 inches in diameter, were produced in continuous lengths of 1,000 to 1,495 feet, the 2-inch-wide 0.002-inch-thick special magnetic shielding tapes being applied by machine and spliced by spot welding for the entire cable lengths for the first time in cable-making history. This assured continuous magnetic shielding throughout the cable. Machine applications of the tapes, supplanting hand application of short lengths of narrower tapes (about ½ to ¼ inch wide), resulted from work by Anaconda engineers, the tape supplier, and a manufacturer of spot-welding equipment.

This unique tricoaxial-cable-pothead assembly (2) is installed at the Plasma Physics Laboratory, Princeton University. It was designed and manufactured for RCA's Industrial Electronic Products Division to the customer's specification, by Anaconda Wire and Cable Company. The three 21-ohm coaxial cables in parallel carry ringing current at 30 to 200 kc. Current up to several hundred thousand amperes is carried when 100 kv is discharged from several 0.5-μf capacitors into a work coil placed around the plasma.

(1)

(2)



(3)

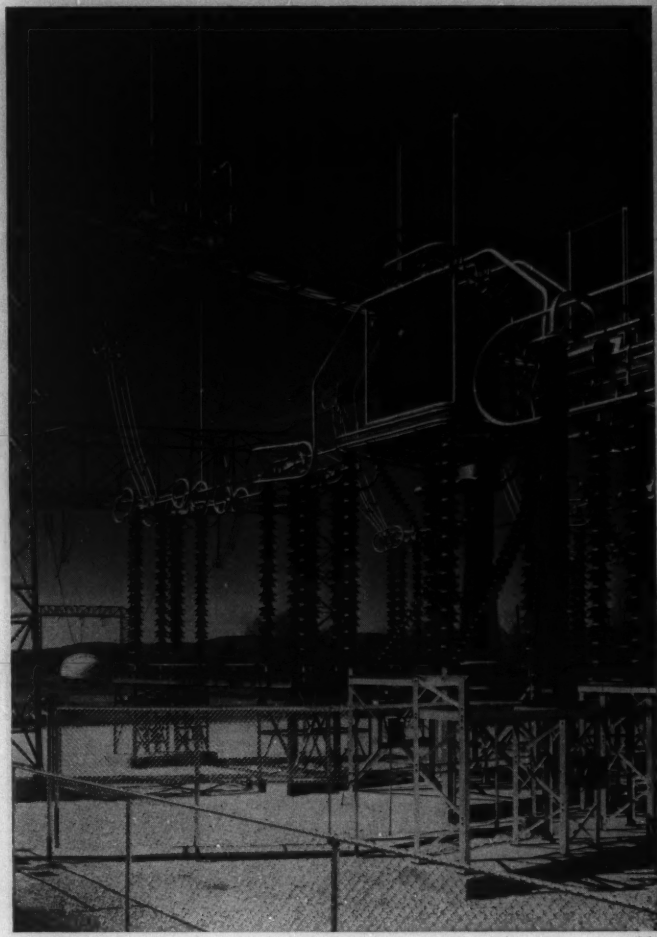
(4)

Cable end seal enclosure or "flexible barrier" (3) is for use in bases of potheads or as a semistop in cable joints. The device maintains a continuous high-pressure oil seal as cable expands and contracts both diametrically and longitudinally with temperature changes. Design of seal is such that there is no possibility of damage to cable insulation from application or functioning of unit. The enclosure is a development of the High Voltage Accessories Division of the Anaconda Wire and Cable Company.

The slapping and intertwining of EHV bundled conductors created by wind or ice dropping can now be pre-

vented by the application of Preformed Spacers (4), manufactured by Preformed Line Products Company, Cleveland, Ohio. The spacers are made up of four matched U-shaped rods which are installed on the bundle as two opposing sets of 2-rod "subsets." The legs of the subsets, being helically formed, are "wrapped" by hand onto the conductors, forming an oval-shaped spacer securely attached, still providing the required flexibility for movement of the cables.

Project EHV (5), sponsored by General Electric with the support of twelve co-operating companies, has been in operation during 1961 to obtain new knowledge useful in designing more economical extra-high-voltage transmission systems. Construction was first completed on a 0.65-mile section strung with a single expanded 2.32-inch diameter ACSR conductor per phase. Testing was started on a 24-hour, 7-day per week basis on January 13, with data being collected continuously on radio noise, corona loss, mechanical characteristics, and meteorological conditions. Tests continued in the region of 500 kv through May 30. Starting July 5, the entire 4.3 miles of line, strung with a bundle of two 1.456-inch-diameter ACSR conductors per phase, was put into continuous operation at 500 kv. The voltage has been varied occasionally to study the effect on radio noise and corona loss. On May 22 the line was operated briefly at 770 kv, believed to be a world's record for high-voltage transmission. Work is continuing on the study of other conductor configurations.



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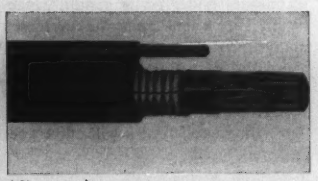

(6)

"Figure-8" cable (6) derives its identification from the cross section of its over-all jacket. The upper loop of the 8 contains the high-strength steel supporting messenger, while the lower loop contains the assembly of insulated conductors. This construction provides installation economies. Produced by Anaconda Wire and Cable Company initially with assemblies of twisted-pair conductors for communication use, the Figure-8 design is being extended to control cable, signal cable, and other applications. Over-all jacket is of high-molecular-weight polyethylene.

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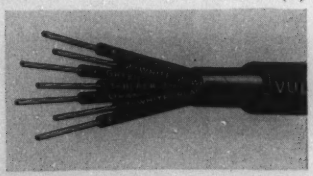

A new industrial control cable with chemically cross-linked polyethylene insulation (7) has been announced by General Electric's Wire and Cable Department. This thermosetting insulation, which has been given the name Vulkene, combines electrical properties similar to those of polyethylene, with thermal properties superior to those of heat-resistant conventional rubber, either natural or synthetic. The result is a cable with improved heat stability and excellent electrical characteristics, better chemical resistance than provided by plastics, and smaller diameters than afforded by rubber.

MASERS

A gaseous optical maser or laser (1) was developed by Raytheon's Research Division. A continuous-wave coherent infrared beam is emitted through the circular window at the near end. The gas maser is built in a low-expansion Invar-rod frame. The device weighs about 35 pounds and is mounted together with the vacuum and gas-handling systems on a laboratory table. The two end assemblies each contain a single flexible metal bellows

(1)

(2)

to permit alignment of the Fabry-Perot mirrors. In order to achieve many successive reflections between them, the mirrors must be adjusted accurately for parallelism. During operation the tube is filled with a mixture of helium at 1.0 mm pressure and neon at 0.1 mm pressure.

A continuously operating optical maser (2) developed by Bell Laboratories uses less power than an ordinary light bulb. It continuously generates a coherent beam of infrared light several hundred thousand times narrower in frequency, or purer in color, than any other coherent light source. With existing communication techniques, large amounts of information can be carried by the beam. With improved techniques under investigation, capacity of the beam could be increased many times. This new maser also uses a mixture of helium and neon gas. It makes possible the extraction of radio signals from the difference between two light waves. It also will allow precise measurement of distance over many miles, with accuracies unobtainable by older techniques. Bell scientists visualize the possibility of using the gas maser for communications through outer space, between air and space craft and, on the ground, through long pipes or conduits.

(1)

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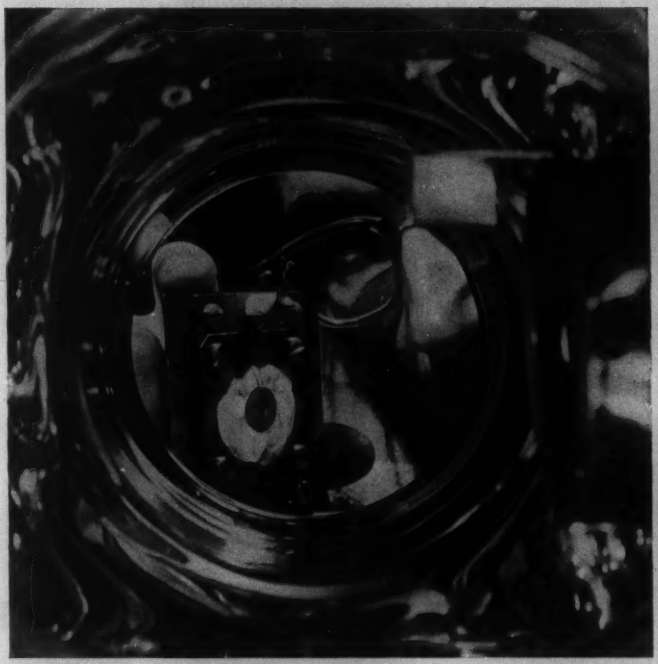
(3)

ENERGY SOURCES

Thermoelectricity projects under investigation at Westinghouse include: a small sun-powered self-contained electric power plant and pumping unit (1), which converts sunlight to electricity by use of a thermoelectric generator; new thermoelectric materials, varieties to samarium sulfide and cerium sulfide (2); and laboratory production of thermoelectric couples for a 5,000-watt power plant (3). RCA's solar cell, highly resistant to damage from radiation in space is shown (4) being placed in a Van de Graaff particle generator. Operating temperatures for thermionic cells of tungsten-cesium (5) have been lowered to 2,200 F by Ford Instrument. Operation of cathodes for high-temperature energy conversion device being checked at General Electric (6). Rated at 50 kva, a solid-state inverter (7) at GE is designed to work with fuel cells and solar devices to convert d-c to a-c.



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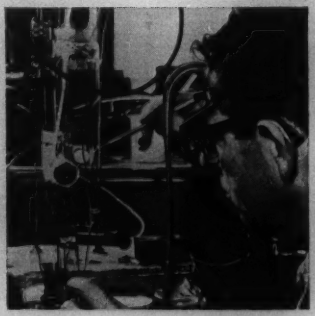

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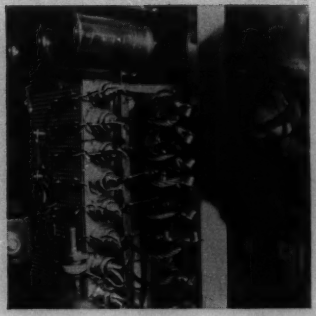

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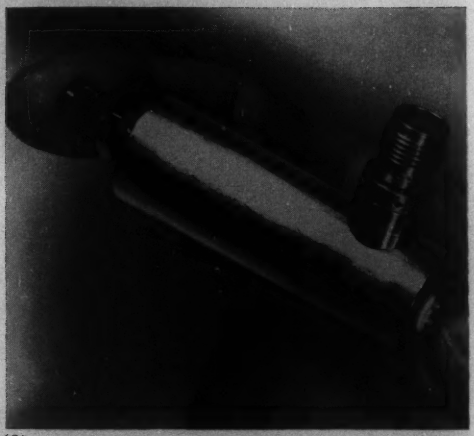


(2)

TUBES

Electronic imaging tube (1), placed on a vehicle in space, will enable scientists to learn more about the stars and the depths of interstellar space. Developed by Westinghouse scientists, the tube is sensitive to the short wavelength ultraviolet light rays emitted by celestial bodies but never reaching the earth's surface since they are screened by the atmosphere. Called the Uvicon, the new ultraviolet-sensitive tube was developed for the Astrophysical Ob-

(3)

(4)

servatory of the Smithsonian Institution for the observatory's Project Celescope.

A C-band device in which a metal-ceramic microwave triode is an integral part of the cavity (2) is being developed by General Electric. Designed as a highly stable local oscillator, the device produces 4 to 10 milliwatts over the 5,250- to 6,050-mc range.

A 5½- by 5½-inch square-face, 3-gun spiral accelerator tube (3) has been demonstrated by Sylvania. The tube has special gun structures which provide excellent beam tracking. Designated type *SC-3090*, it employs electrostatic focus and deflection.

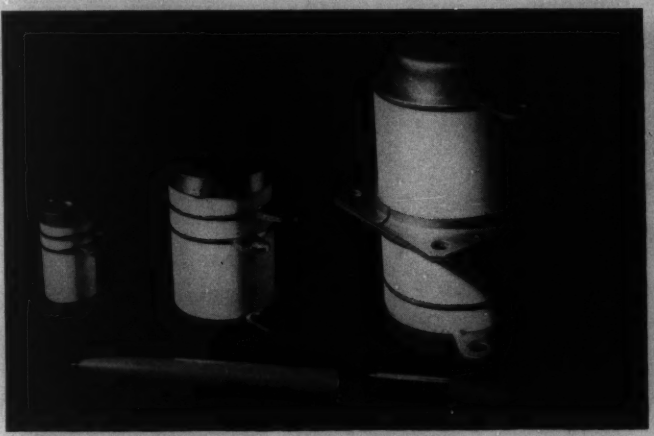
Intended to sniff the thin atmospheres of near space and to measure their density, several ionization gauges (4) have been designed and built by Westinghouse for NASA's Goddard Space Flight Center. Tested in space as part of the instrumentation for an Aerobee Hi Rocket, one of these gauges provided direct measurements of pressures and densities prevailing at altitudes from 70 to 125 miles.

A miniature radar and television display device (5) has been developed at Westinghouse. It has been nicknamed the "Private Eye" because its display is viewed by only one person at a time. Typical uses will be in radar installations, in private aircraft, and in boats, where space requirements and equipment costs are critical. The essential element is a high-resolution cathode-ray tube 7 inches long whose 0.60-inch-diameter screen is observed through a magnifying eye piece.

Three new high-temperature diode rectifiers (6) developed by General Electric are rated (left to right): 0.15 ampere, 2 amperes, and 10 amperes. They operate in ambient temperatures up to 500 C. The tubes were designed for use in a high-temperature generator regulating circuit for Mach 3 aircraft as well as for other military aircraft and missile applications.

Technician at the headquarters plant of Sylvania's Electronic Tube Division checks receiving tube voltages on an automatic aging conveyor (7) prior to final testing. The company began the manufacture of receiving tubes in 1924, and produced its two billionth in December 1960.

(5)



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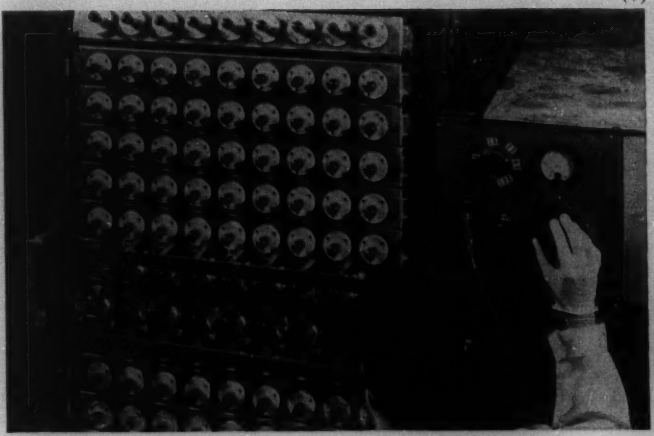
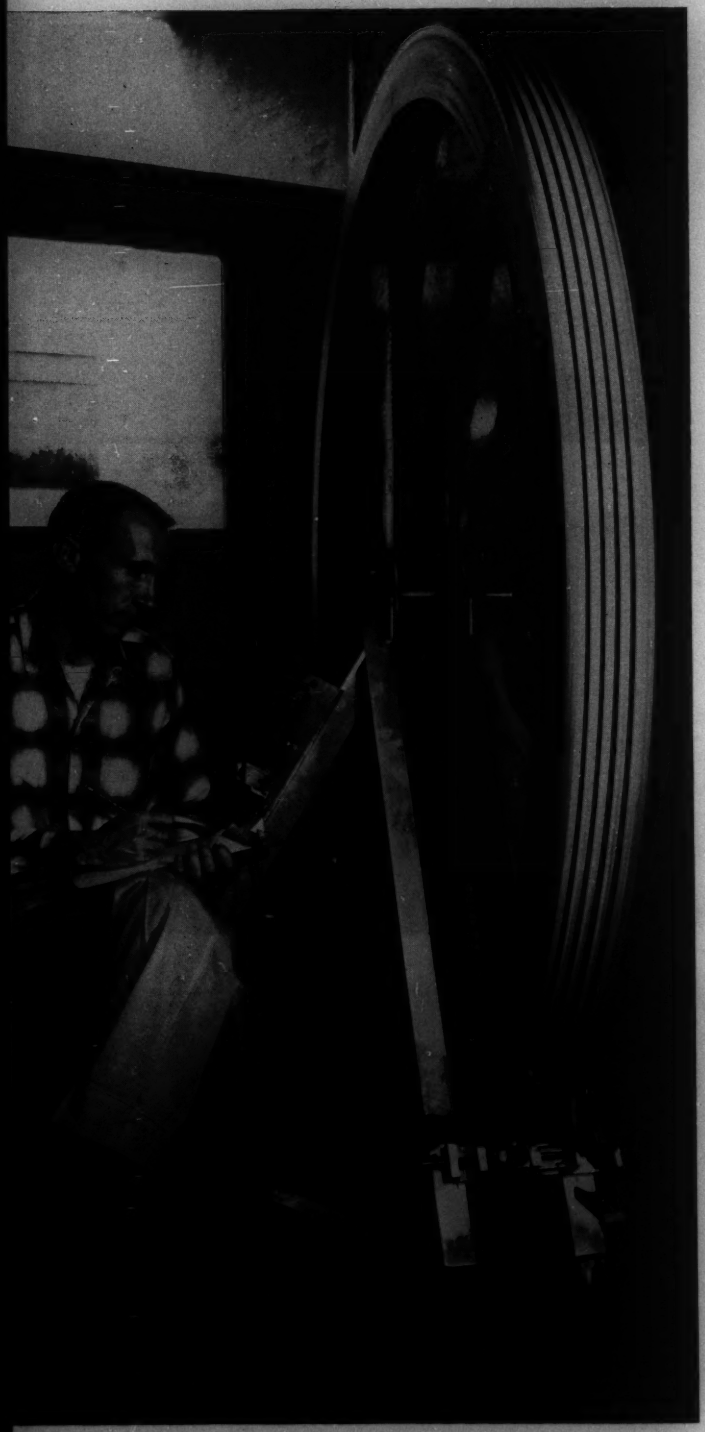




(1)

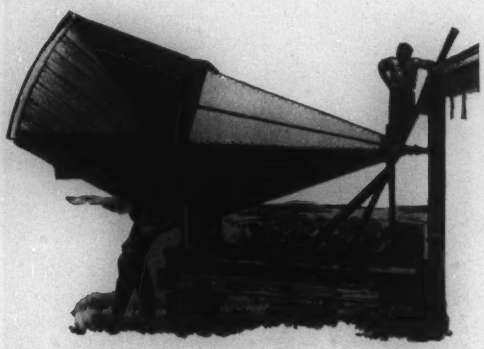
Special-purpose antennas (1) for investigating micropulsations in the earth's magnetic field have been designed and constructed by the National Bureau of Standards. These loop antennas, each 6½ feet in diameter and containing 32,000 turns of nylon-coated copper wire, will be used to collect data on the behavior of micropulsations and to discover how they can be related to unusual manifestations of solar or magnetic activity. Results of this recently initiated program are expected to provide further useful information about ionospheric disturbances arising from extraterrestrial sources which may affect radio communications.

Rigid radome (2), 150 feet in diameter, designed by the MIT Lincoln Laboratory for use at radar frequencies up to 10,000 mc and higher, was completed in September 1961 on Haystack Hill in Tyngsboro, Mass. The structure consists of some 3 miles of aluminum beams, held together by 15 tons of nuts, bolts, and washers, and covered with an acre and a half of glass-fiber-reinforced plastic panels 9 to 15 feet on a side and only 0.030 inch thick. Constructed under U.S. Air Force contract, this radome will house a revolutionary new radio communications and radar research facility, scheduled to be completed early in 1963.

Space communication scientists at ITT Federal Laboratories (3) will use the 40-foot antenna shown, to beam signals at outer space and to receive radio waves from satellites and stars or planets. The ITT research and manufacturing division has received the first "earth–space" radio license granted by the FCC to a private concern, permitting experimental work in satellite and related space communications. One of the research goals is to collect data that will aid in development of the future world-wide satellite telephone–television system.

This electronically steerable array radar (4) is capable of both spotting and tracking hundreds of flying objects simultaneously. Designed by the Rome Air Development Center in conjunction with Bendix Aviation, it eliminates the need for complex mechanical rotating devices.

ANTENNAS



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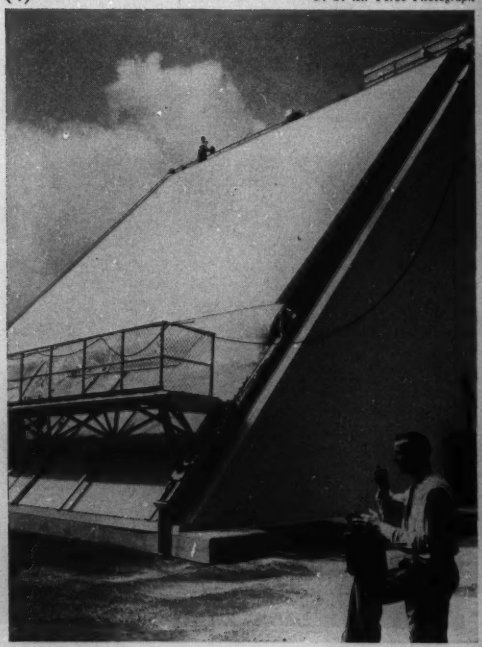
(4) *U. S. Air Force Photograph*



RESEARCH

(1) *Official U. S. Navy Photograph*

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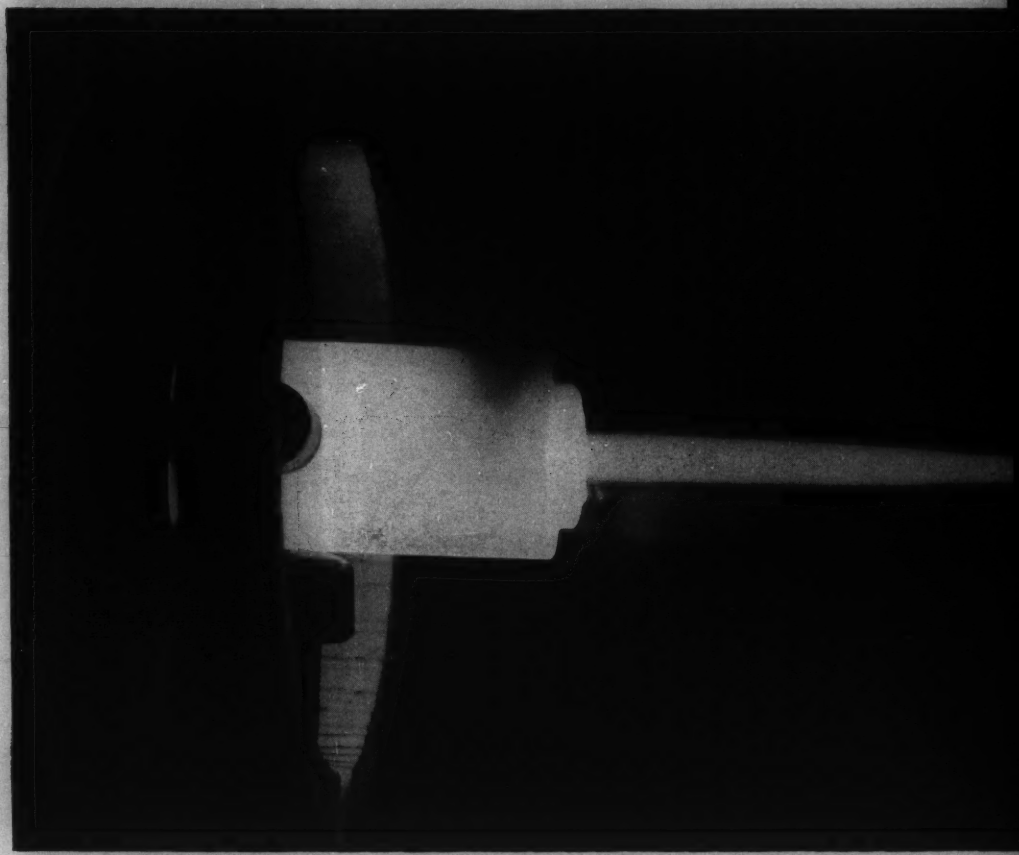


(5)

A 2-megajoule capacitor bank (1) was recently placed in operation at the U. S. Naval Research Laboratory in connection with an experimental program in high-temperature physics. Discharge of the capacitors through a single-turn coil produces currents of nearly 20 million amperes and magnetic fields of over 100 kilogauss. The magnetic field is used to compress and confine a plasma on the interior of the single-turn coil. With the aid of such a device, plasma temperatures of about 20 million K may be studied.

Furnace (2) is used at Bell Telephone Laboratories to bake experimental magnetic coils. The process is part of a discovery expected to produce very strong magnets which operate on very small amounts of electric power. The experimental samples are contained in a metal tube which is heated red hot by an r-f coil contained in an evacuated bell jar.

Brilliant flash of light (3) is generated by the impact of a single supersonic drop of water, shot like a bullet into solid steel at speeds up to 3,400 miles an hour. Scientists at the Westinghouse research laboratories are using the water "bullets" to study water drop erosion, which occurs on turbine blades and the surfaces of high-speed aircraft and missiles flying through rain.

Scientists of RCA are developing a new radio-frequency technique that may be used to propel space vehicles on long interplanetary voyages. Dr. G. A. Swartz (4) observes experimental operation of the technique, which uses ultra-high radio frequencies to accelerate charged particles—electrons and ions—to high velocity. With further development, process is expected to create enough thrust for space-craft propulsion in gravity-free environment of outer space. In laboratory equipment shown here, particles are accelerated upward from base of glass cylinder, and their velocity is measured by probes visible in upper half of tube.

General Electric's *XT-761* arc jet engine (5) is undergoing performance and endurance testing at the company's Flight Propulsion Laboratory Department. At 30-kw input, this advanced a-c engine has produced a design thrust of ½ pound and a specific impulse in excess of 1,000 seconds. The *XT-761* was developed under a NASA contract.

LIGHT

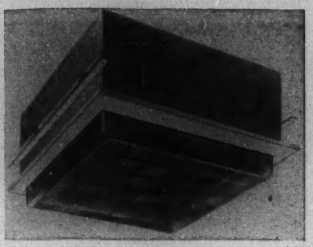
Shallow prismatic Holophane Controlens unit (1), with flat or drop trim lens, features positive automatic latching: press the lens to open, push on trim to close.

The first installation of a solid-state lighted sidewalk (2) has been completed by Sylvania at Salem, Mass. Unlike other lighted sidewalks that have required conventional light sources to be placed beneath a transparent or opaque surface, the Sylvania "Panelescent" sidewalk is composed of solid pieces of steel that are embedded in the ground and produce light through the principle of electroluminescence.

Another Panelescent lamp, said to be the world's largest electroluminescent lamp (3), measures 8 feet by 2 feet and has a brilliance of 5 foot-lamberts, a light level equivalent to that found in many restaurants and cocktail lounges. O. H. Biggs, Sylvania vice-president, is shown placing his hand on the lamp, which is cool to the touch. The lamp is constructed of a steel base with ceramic and phosphor coatings to which an electrical charge is applied to produce light. The panels are expected to last more than 5 years.

A B-52 bomber can land on top of a new airport lighting fixture (4) without damaging it. The fixture, manufactured by Sylvania, is to be embedded in airport runways and taxiways. The use of these fixtures will provide more definition of runways and taxiways when they are installed as center lines.

High-level assembly-line lighting fixture (5) by Paramount Industries, Inc., can provide lighting intensities of 500 foot-candles and even more. It is engineered to operate either two or four 1,500-ma lamps, 96 inches long, and is fully gasketed to keep out dirt.



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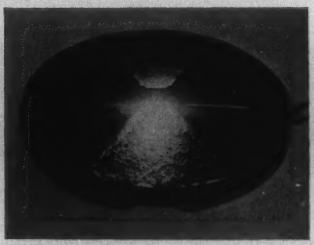

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TELEVISION

A combination of a high-power telescope and high-sensitivity television camera tube (1) is being developed by General Electric for optical tracking of space probes. Based on earlier tracking experiments, GE engineers indicate that visual tracking of moon probes to impact or orbit is possible.

Ampex *VR-8000* single-head closed-circuit Videotape recorder (2) uses a 26½-inch diagonal track across a 2-inch tape to record one complete television picture field per revolution. Elimination of complexities needed to meet broadcast standards resulted in about 60 per cent reduction in size and cost over broadcast-standard machines.

A television comparator (3) that permits examination and precise measurement of miniature solid objects, with magnification up to 300 times, was exhibited by General Precision, Inc.'s GPL Division. This closed-circuit television system enables an operator to examine small electronic components in minute detail.

RCA's transistorized television tape recorder, the *TR-2*, is a compact, single-console unit combining improved performance with simple operation (4). Use of transistors results in a one-third saving in floor space required.

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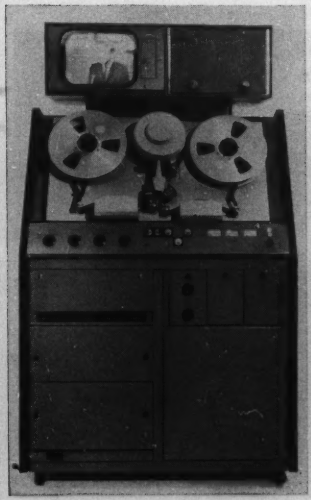

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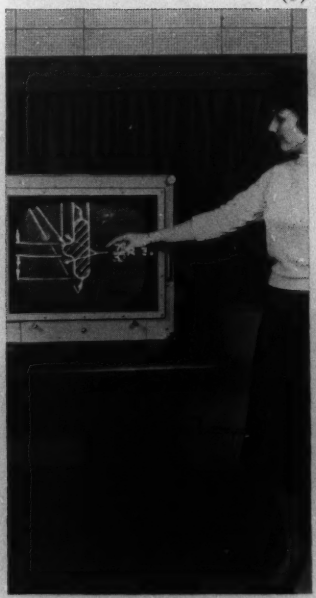

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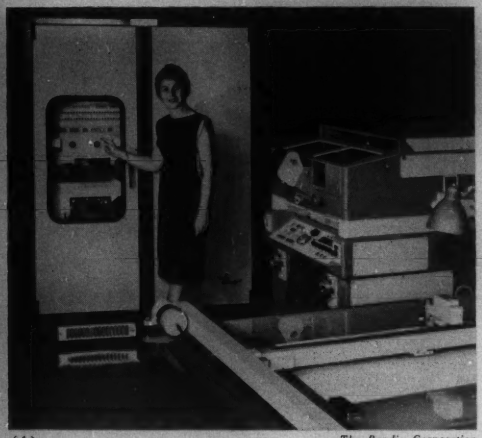
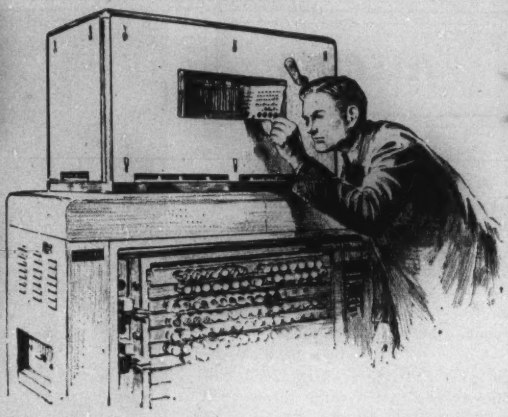


(1) *The Bendix Corporation*



(2)

COMPUTERS

(1) Special-purpose computer (*upper left*) controls plotting movements in analytical-type stereoplotter which produces contour maps from aerial stereo photographs. The fully transistorized computer was developed by Bendix Research Laboratories Division and the mechanical and optical components (*upper right and foreground*) by Ottico Meccanica Italiana, Rome, Italy. The stereoplotter was built for Fairchild Camera and Instrument

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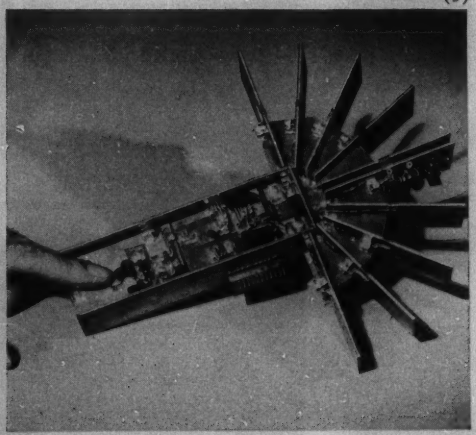

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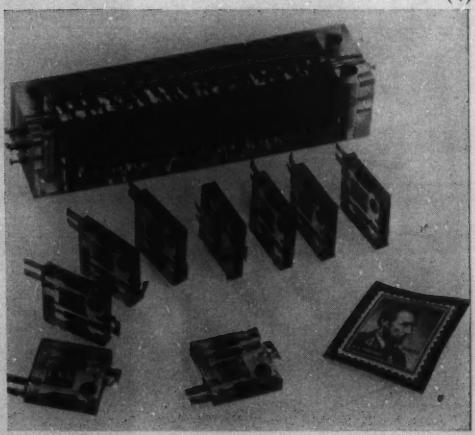


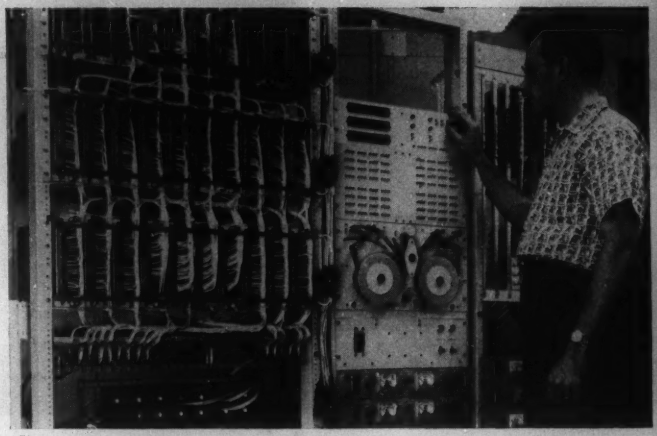
Corporation under contract with the U. S. Air Force.

Computer control system (2) to direct output of generating units was developed jointly by Minneapolis-Honeywell Regulator Company and Philadelphia Electric Company. The Honeywell *290* computer "tells" 34 turbine–generators the share of electric company's total power requirements each is to supply at minimum incremental cost.

Pointing the way to new computers which will operate 10 to 100 times faster than those presently used, an experimental tunnel-diode memory (3) developed by Bendix Research Laboratories can perform a complete read–write cycle 20 million times each second. The fan-shaped configuration minimizes the length of signal paths, an important factor in high-speed operation.

Waferlike postage-stamp-size magnetic shift register elements (4) being produced by General Electric operate at an information rate of 100 kc at a peak shift power of only 0.1 watt. Each element stores a single binary bit of information, and can be assembled in shift register modules up to 10 elements per inch.

With an effective clock rate of 50 megapulses per second, the *FX-1* computer (5), developed at the MIT Lincoln Laboratory, is 10 times faster than general-purpose digital computers in general use today. The magnetic-film main memory has a read–write time of only 0.3 microsecond.



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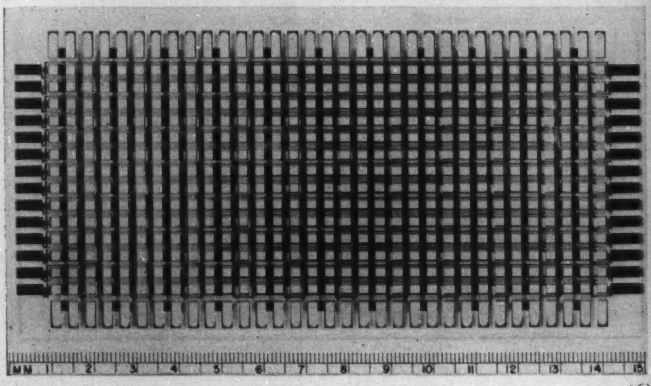

(6)

(7)

Random access memory implemented with cross film cryotrons (6) was built at the GE Research Laboratory. This 3- by 6-inch substrate represents considerable achievement in the fabrication technique, which has been matched by progress in logic design and development of room temperature input–output circuits.

Dr. H. F. Olson, Director of RCA's Acoustical and Electromechanical Research Laboratory at Princeton, N. J., changes arrangement of control circuit in an experimental electronic system that can help a composer to create new music by suggesting variations and new tone combinations based on his original idea (7). The system could be used by a composer as a tool to develop variations based on any style in which he wished to work, and in accordance with his basic theme.

SATELLITES

A 3-dimensional display system (1) with broad application in air traffic control, missile tracking, antisubmarine warfare, and related fields has been developed at International Telephone and Telegraph Corporation's laboratories in Nutley, N. J. Pinpoints of light representing airplanes, missiles, satellites, or submarines move through the display as directed by a computer or radar pulse to provide operators with a clear visual picture of the situation under study. When employed for air traffic control, the confines of the display can be made to represent the air space surrounding an airport control tower. Grid lines repesenting specified distances can be infused into the display to show the operator the precise position of each aircraft.

Earth path indicator (2), an instrument developed by Minneapolis-Honeywell for the U.S. Project Mercury man-in-space program, will serve as a sort of space compass for the astronaut. It will tell him where he is in relation to the earth as he orbits through space. This information will be vital when he fires retro-rockets to begin his re-entry into earth's atmosphere. Globe revolves slowly to correspond to the movement of the earth.

(1)

(2)

(3)

(4)

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IBM Corporation

The astronaut will view the globe through the window at lower left in the same manner as if he were actually seeing the earth below him through a window in his capsule.

Interfaces with a ground control station, parent vehicle, and astronomical references are simulated for a space vehicle attitude control system by the equipment shown here at General Electric's Missile and Space Vehicle Department (3). The control station and inverted tripod structure component platform simulate satellite vehicle lift-off, separation, and in-space disturbance conditions by transmission of pulsed-frequency signal commands to gas reaction system receivers. Silvered tanks supply the reaction system gas to jet nozzles.

Orientation and action of the reaction system is telemetered from the hexagonal component platform on the spherical gas bearing to a PAM/FM/PM ground telemetry station. This preserves separation of the platform from hard-wire restrictions to 3-axis rotational freedom.

Project Mercury space capsules contain an attitude stabilization and control system (4) developed by Minneapolis-Honeywell. Logic panel (*left foreground*) contains over 3,000 electronic connections that make vital decisions during a capsule's flight through space. On a manned ballistic flight, this computer, working in conjunction with gyroscopes and reaction jets, stabilizes the capsule to prevent tumbling, positions it properly during the flight, and repositions it for reentry.

(5) Performance of Saturn—which will send multiton payloads into earth orbit around the moon and back and into deep space—will be polished while the huge vehicle is on the ground. Saturn's 1,500,000-pound-thrust booster will be mathematically "flown" thousands of times within the IBM *7090* data-processing system before reaching the launching pad within the next year, with each flight taking only a few minutes. Here Dr. Wernher von Braun (*right*), Director of Marshall Space Flight Center, reviews solar-system flight calculation with Dr. Helmut Hoelzer (*left*), Director of the center's Computation Division; and Dr. Eberhard Rees, the center's Deputy Director for Research and Development.

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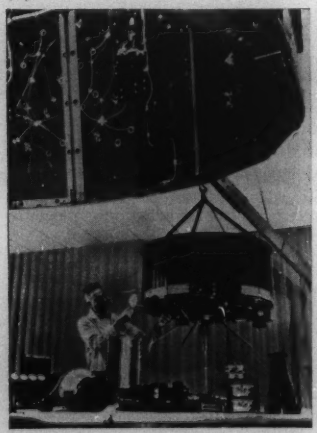

Shown in final assembly for the National Aeronautics and Space Administration at RCA's Astro-Electronics Division, Princeton, N.J., is Tiros III television infrared observation satellite (6). In background, flight model receives final adjustment from Herbert De Cerbo, who is placing one of two omnidirectional infrared sensors developed by NASA for initial use on Tiros III. In foreground are parts of additional test model, including camera, television tape recorder, and additional equipment, underneath a cylindrical "hat" which covers the payload in the assembled satellite.

A space guidance "first" was achieved by the gyro guidance system shown (7) when it electronically steered the Scout space vehicle from moment of launch through to orbit. The guidance system, developed by the Aeronautical Division of Minneapolis-Honeywell, was the first miniaturized gyro system to put a satellite in orbit. It functions independent of ground control, whereas other space guidance systems rely on radioed directions.

MACHINERY

A special-purpose machine (1), so nearly human that it learns, makes decisions, profits by its mistakes, and tells how to solve problems that baffle man has been developed by the Raytheon Company. Like a human, the Cybertron, as Raytheon calls its learning machine, is "alogical"—learning by trial and error, relating new situations to past experience, and constantly improving its skill. The Cybertron tackles problems for which no formula is known. It figures out its own method of attack, gives the answer, and can tell how it arrived at the answer.

The Ampex Corporation wide-band rotary head (2) was designed for instrumentation recording and reproduction of two data channels up to 4 mc in bandwidth. Two systems developed during 1961 at Ampex permit the rotary head to be used as a continuous recording device, free from switching transients, and with minimum time errors of 20 millimicroseconds or less.

The Westinghouse "Life-Line H" totally enclosed d-c motors (3) feature a newly designed aluminum air-to-air heat exchanger in ratings of 75 to 250 hp at 1,150 rpm. Generators in corresponding ratings also are available. An a-c totally enclosed vertical motor, to drive the blowers, is recessed in the d-c motor commutator bracket to reduce the over-all height of the complete unit. The compact heat exchanger is made up of welded fin-type aluminum ducts.

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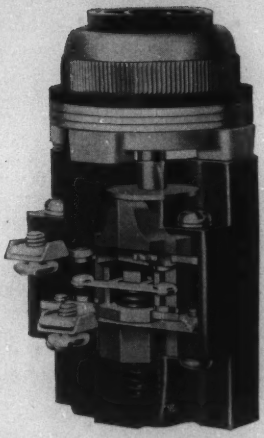

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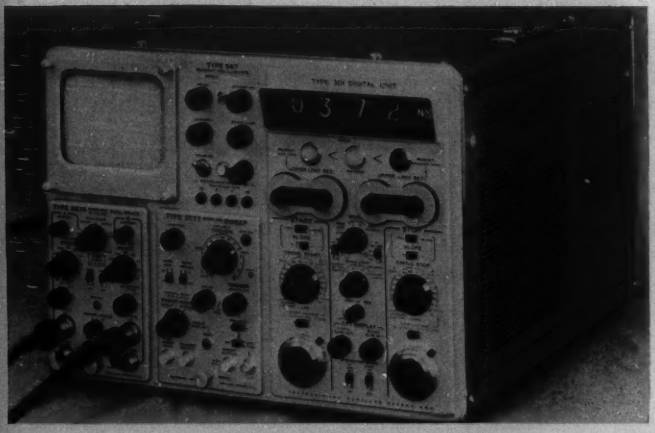

(5)

A cutaway view (4) is shown of a Bulletin *100* push button control, introduced by The Clark Controller Company. Devices in each of the three available lines include push button units; selector switch units; standard pilot lights; and push-to-test pilot lights or lighted push buttons.

Adding readout convenience to dual-trace applications, the Tektronix type *567* oscilloscope (5) presents simultaneously an analog display on its 5-inch cathode-ray tube with a digital presentation on the automatic computing programmer. The user can select

and intensify the actual points for automatic normalization on the cathode-ray tube waveform which is to be measured. Then the corresponding up-to-4-digit decimal units of actual measurement can be read directly. Indicators light to designate the readout status whether in the programmed readout zone, below it, or above it. The program is set only once for successive similar readings.

Engine, vehicle, or machine vibrations as close together as 2 cps can be quickly separated and analyzed with a synchronous vibration analyzer (6) developed by General Motors Research Laboratories. Readout shows amplitude and frequency of a particular unbalance. Once "locked on," the instrument will automatically track a disturbance throughout the speed range of 500 to 10,000 rpm. Precise filtering of the incoming signal is achieved with a synchronous rectifier instead of conventional tuned circuitry, the rectifier switching signal coming from a square-wave oscillator adjusted to the frequency of the desired part. Automatic tracking is accomplished with a speed-controlled bias fed to the oscillator from ignition, drive shaft, or other component.

Completely automatic power is now being supplied by Allis-Chalmers equipment (7) for computers and emergency lights in the Tech Lab building, where all data on information received on missile performance at Patrick Air Force Base, Fla., are reduced. The equipment consists of two groups of 480- and 208-volt switchgear, 30 low-voltage circuit breakers with battery and charger, and four 100-kw diesel generators with separately mounted radiators and air starting equipment.

(6)

A new point-to-point positioning control system called RAPAC has been developed by Square D Company (8). Providing accuracy to ± 0.001 inch and repeat accuracy to ± 0.0005 inch, RAPAC directs a wide variety of machine tools, including drill presses and boring mills, and is also suitable for multiple axis control. It utilizes punched tape for predetermining sequences. The system features a unique linear transducer which is subject to neither wear nor deterioration. The transducer indicates the direction of travel toward the desired positioning point at all times. This is accomplished without the cyclical transition from one measuring scale to the other found in synchros and other systems.

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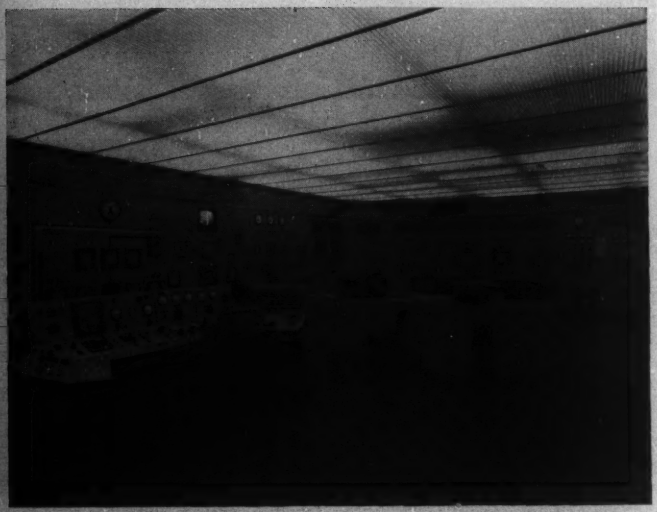
REACTORS



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(1) Experimental Breeder Reactor 2 (EBR-II) is a facility of the Argonne National Laboratory, a U. S. Atomic Energy Commission research and development establishment. This facility, being completed at the National Reactor Testing Station in Idaho, is designed to demonstrate the "breeding" of fissionable nuclear fuel while the reactor is in operation. The EBR-II will include a completely integrated fuel-processing and refabrication setup. Shown is the EBR-II control room, with the reactor console on the left.

Rising from the plains of southeastern Idaho is this imposing "ship in the desert," the land-based prototype nuclear powered plant (A1W) for the United States Navy's large atomic-powered surface ships (2). In the foreground is the cooling tower for cooling water used in the A1W plant circulating system. Behind it is the building housing the 2-reactor propulsion plant. The nuclear propulsion plant was designed and developed by Westinghouse Electric Corporation at the U. S. Atomic Energy Commission's Bettis Laboratory, Pittsburgh, Pa., under the direction of and in technical co-operation with the Naval Reactors Branch of the Atomic Energy Commission. Eight nuclear reactors are being used to power the aircraft carrier *USS Enterprise*, which was built by the Newport News Shipbuilding and Dry Dock Company. The 85,000-ton carrier is capable of speeds "in excess of 30 knots."

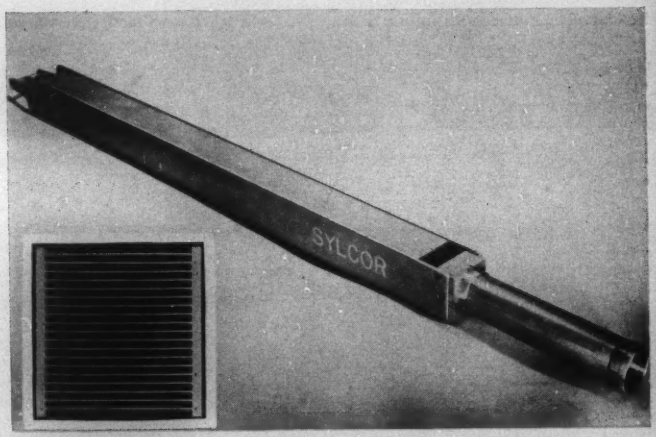
(3) General Electric consultant Samuel Untermyer II *(left)* shows the fast neutron counter which forms the heart of his "neutron telescope" to electronics engineer T. D. Andrews of the company's Atomic Power Equipment Department. The neutron telescope, a sensitive electronic device which permits nuclear engineers to "look" through the thick steel walls of an atomic reactor to see how much

steam it is producing, has been tested at the Vallecitos Atomic Laboratory, near Pleasanton, Calif., and at the Dresden Nuclear Power Station, near Chicago. The device is basically a fast neutron counter in a special tube, mounted above the core of the reactor, which counts fast neutrons coming up out of that section of the reactor through 6 feet of water and several inches of steel. From the number of fast neutrons coming out of the reactor, the engineers can tell how much steam that part of the reactor is making, or literally how hard that area of the reactor is running.

This aluminum plate-type nuclear fuel element (4) is one of hundreds that will be manufactured by the Sylcor Division of Sylvania Electric Products Inc. for the high-powered engineering test reactor near Idaho Falls, Idaho, as part of a contract awarded Sylvania by the Atomic Energy Division of Phillips Petroleum Company. The fuel, a uranium–aluminum alloy, is encased in the aluminum sheath in plate form. The series of plates *(see inset)* are exactingly spaced to form 18 water-cooling channels for heat dissipation. The contract, for more than a thousand elements, is the largest awarded to private industry for the production of nuclear fuel elements for test reactors.

Being loaded aboard a flatcar (5) at Allis-Chalmers West Allis (Wis.) Works is a 36-foot-high pressure vessel for a 200-mw (thermal) reactor with nuclear superheater. The equipment is for the Pathfinder Atomic Power Plant in Sioux Falls, S. D. The vessel weighs 125,000 pounds. Also being installed at the site is an Allis-Chalmers 66-mw turbine–generator. The turbine is constructed in such a way that its horizontal center line is below the operating floor level, a patented design which serves to provide maximum shielding from radioactive elements.

(3)



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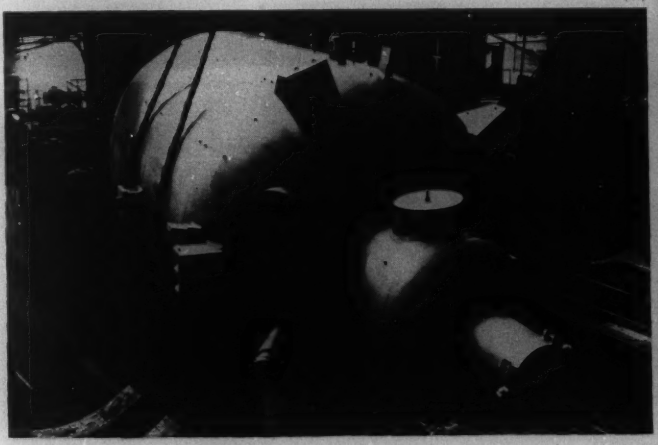

RECEIVING EQUIPMENT

The control console and three panels shown (1) are part of the Defense National Communications Control Center of the Defense Communications Agency, located near Washington, D. C. The console and panels, part of a complex communications control system designed and installed by the Philco Corporation, aids in keeping U. S. Armed Forces communications traffic flowing smoothly. The control center provides the means to monitor and control this gigantic traffic load. Communications information is processed by the center and the status of the entire world-wide system is displayed on the 8-foot-high panels so that systems control can be exercised.

Special 3-position switch (2) enables radio users to select built-in impulse noise suppression, intermodulation rejection, or standard receiver operation. This device extends the operating range of a receiver and provides more reliable reception in heavy-traffic areas.

(3) A 60-channel tactical version of the 600-channel *AN/FCC-17* multiplexing system designed and manufactured by the Lenkurt Electric Company for the U. S. Air Force's Rome Air Development Center can be either towed or airlifted into position. The *AN/FCC-17* is a solid-state single-sideband suppressed-carrier system for use on cable and line-of-sight or tropospheric scatter radio circuits. It will transmit voice, data, or graphics, or a combination of these services, on any channel without restriction or special treatment.

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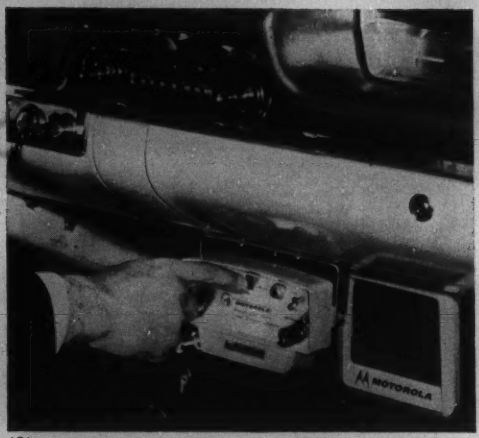

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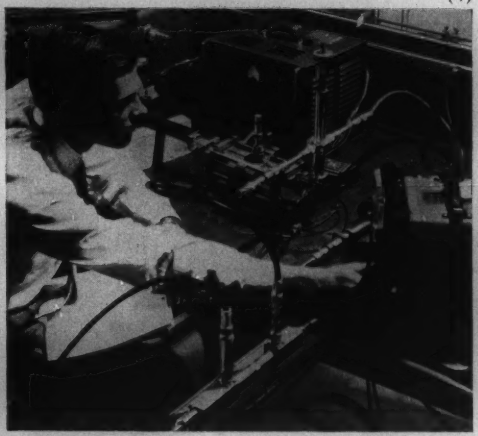

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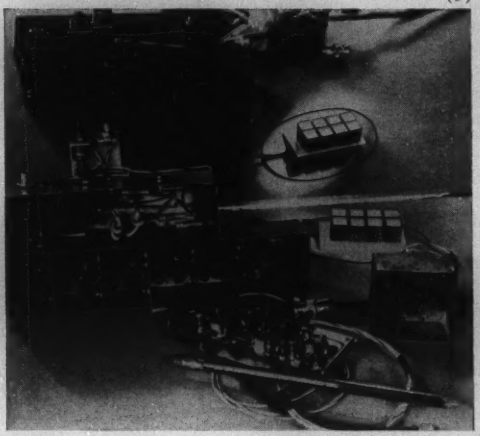
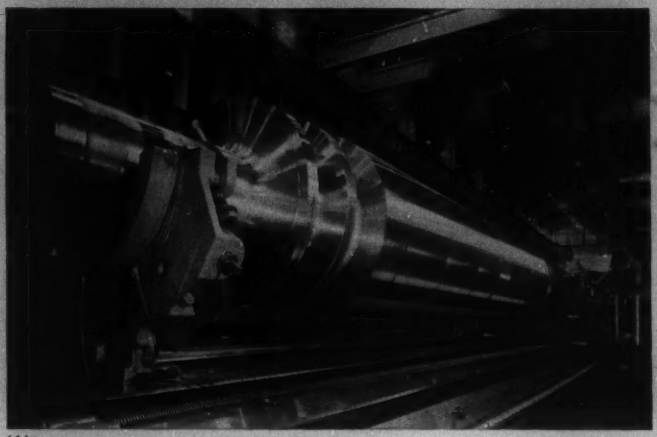


General Electric Company engineer Clark Gittinger uses a low-noise parametric amplifier (4), which he developed, along with Gunther Fenner, for picking up signals from the U. S. Army's deep space probe as it hurtles on into space near the moon. Space vehicle is being tracked from station set up on the roof of General Electric's Research Laboratory. The amplifier was built from key parts furnished by GE's Heavy Military Electronics Department.

An ultrareliable air-borne radio receiver (5) adaptable to microminiaturization has been displayed by Sylvania Electric Products Inc. Developed for the Air Force, the diminutive solid-state receiver was a mock-up of its circuitry reduced to 1/10 the present size through the use of microminiaturized electronic elements. The receiver circuitry is shown *(top)*, together with the mock-up *(right rear)* of the microminiaturized version. The receiver will operate more than 10,000 hours (nearly 14 months) without failure. The current average time between failures for a typical air-borne radio receiver is about 450 hours.

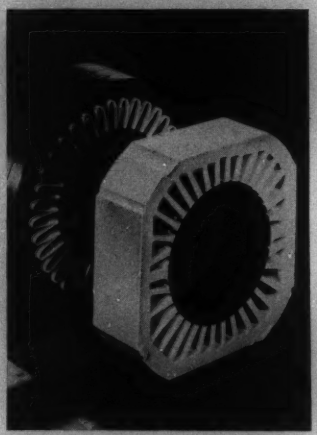
ROTATING MACHINERY



(1)

Huge 1,800-rpm steam turbine-generator rotor (1) is being rough-machined in a large engine at the General Electric Company's Large Steam-Turbine-Generator Department. Weighing 116 tons, it is 38 feet 9½ inches long and 59¼ inches in diameter. The steel ingot for this forging was vacuum cast—typical of such forgings now in general use for large 3,600- and 1,800-rpm generators. The vacuum casting of such ingots reduces the hydrogen content to such a low level that the risk of hydrogen embrittlement is avoided. Vacuum casting also improves the quality of forgings in numerous ways, such as, for example, reduced size and improved distribution of nonmetallic inclusions.

(2) Stator in the foreground is coated with Alkanex powder, a General Electric Company product being used for appliance motors. Because the powder is bonded into the stator iron, slot configurations may be quite irregular and the stator much thinner. The stator shown in the background is an earlier model with plastic slot liners for insulation. The new insulation has permitted design engineers to increase motor torque in the same



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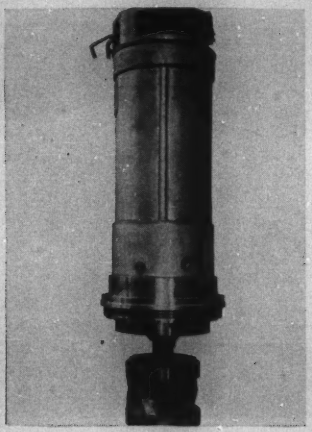

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motor package or to utilize present torque requirements in a smaller package. Possibilities of a shorter, lighter weight 2-speed motor allow the appliance manufacturer more flexibility in designing future home laundry equipment. According to company engineers, the new insulation will decrease motor grounding possibilities, decrease leakage current, and provide increased moisture resistance and longer motor insulation life at higher temperatures.

Canned motor pump (3) manufactured by General Electric circulates 26,000 gallons per minute of 530 F water. The units are for installation in the SENN Boiling Water Atomic Power Plant, located at Punta Fiume, Italy.

The motors feature a 3,000-volt insulation system similar to the 4,000-volt insulation used in the canned motor pumps operating at Commonwealth Edison's Dresden Nuclear Power Station, and a new thrust bearing material which extends operating limits.

Giant rotor (4) for 1,800-rpm generator is part of Consolidated Edison Company's Unit 5 addition at their Astoria (N. Y.) Station. The Allis-Chalmers 3,600/1,800-rpm close-coupled cross-compound steam turbine-generator, with a capacity of 410,000 kw, will be placed in service by mid-1962. This is a duplicate of Unit 4, which has been in operation since early 1961. The 4-pole generator is hydrogen-cooled and fully supercharged. The hydrogen gas is circulated by the 5-stage axial blower, which is mounted on the shaft in the foreground. Steam conditions for this unit are 2,000 psig, 1,050/1,000 F and 2.0 inches Hg absolute exhaust pressure.

An induction stirring system (5) from the Westinghouse Electric Corporation for mixing molten steel in electric arc furnaces works on the principle of passing magnetic fields through the melt to produce a stirring action. The stirrer's main application is with arc furnaces of 30 to 200 tons that are required to produce high-alloy steel. The system consists of a rotating 2-pole d-c magnet, 6 feet in diameter, and weighing 16½ tons, driven at 25 to 60 rpm. The magnetic field generated is swept through the molten bath of steel and produces a series of eddy currents. The eddy currents, in turn, react with the magnetic field of the stirrer to move the steel. The drive system is a steel-mill-type totally enclosed adjustable-speed motor.

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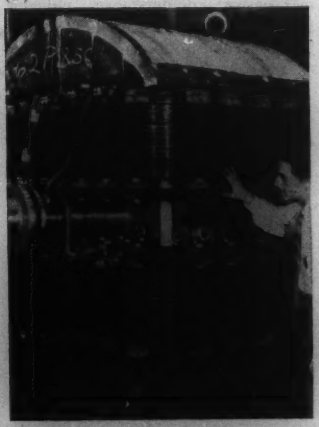

A 200,000-hp hydraulic turbine runner (6) for the Niagara Power Project is shown being loaded onto a barge at the dock site. The size of the runners necessitated shipment from Eddystone, Pa., to Niagara Falls via inland waterways.

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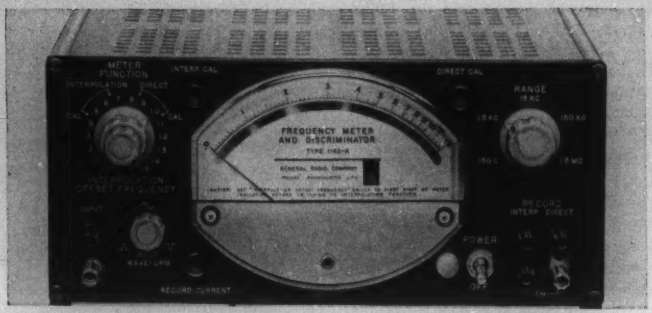

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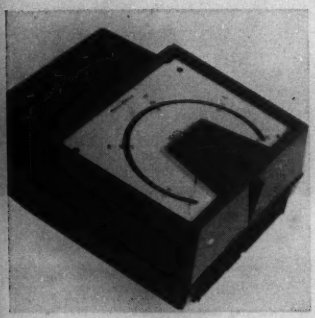

(3)

INSTRUMENTS

General Electric's Atomic Power Equipment Department has announced the availability of a self-testing flux amplifier (1) featuring wide range and freedom from drift. It is designed to provide reactor power level data for visual display, recording or logging, control, and shutdown or scram operations.

The Polarad Electronics Corporation transistorized microwave receiver (2) is actually four distinct mobile receivers in a single instrument: an AM-FM receiver; a field intensity receiver; a pulse, pulse time, or pulse position demodulator; and a sensitive microwave power meter.

Portable Westinghouse a-c voltmeter (3) features taut-band suspension frictionless mechanism, eliminating wear between moving parts and greatly reducing maintenance. The moving element of the taut-band suspension system is suspended between bands of high-strength metal ribbon which are supported on springs at each end.

The Polarad transistorized spectrum tape recorder (4) features dual-track operation, permitting simultaneous recording of spectrum and vocal commentary or time reference signals.

The General Radio type *1142-A* frequency meter and discriminator (5) will directly measure frequencies between 3 cps and 1.5 mc. The nominal accuracy is 0.2 per cent of full scale for all but the extremes of its frequency coverage and accuracy.

The National Bureau of Standards has recently improved its services for the calibration of inductive voltage dividers (6). With the aid of special capacitance bridges, extremely accurate calibrations are given for this type of device.

The Leeds & Northrup "Speedomax H Azar" (7) is a d-c voltage recording system with a module for continuously SPAN and ZERO selection.

Leeds & Northrup's *8696* is a small, inexpensive, double-range millivolt potentiometer with manual reference junction compensation (8). Other in-

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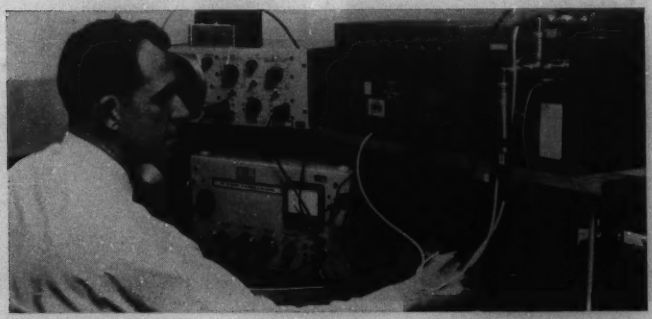

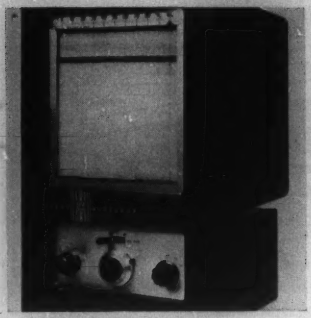

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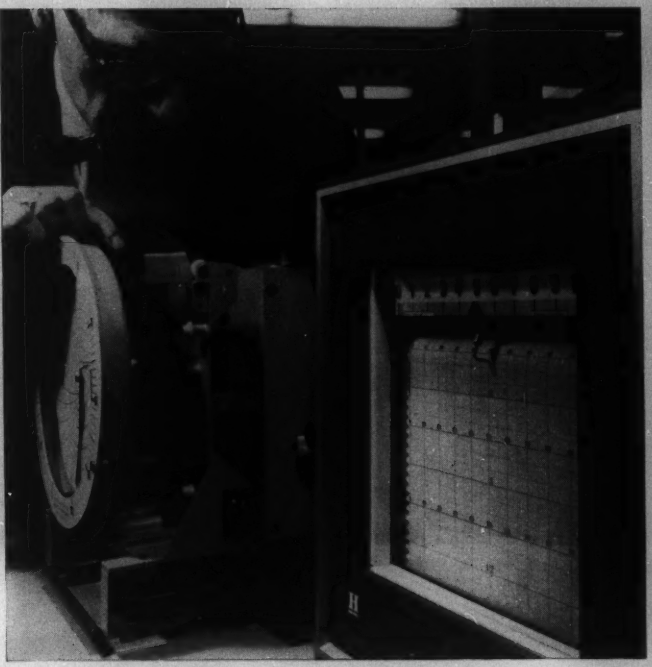
struments of this type are a single- and a double-range direct-reading temperature potentiometer.

The Westinghouse "Unicode" (9), a simplified supervisory system that handles the control and indication of a single device at a remote station, will close and trip one device, while at the master station continuously indicating with a lamp whether the device is open or closed and sounding an alarm when the position changes.

The "ElectroniK 17" potentiometer (10) was recently introduced by Brown Instruments Division of Minneapolis-Honeywell. An electromechanical strain gauge is used as the rebalancing mechanism in place of the conventional slidewire.

Use of an internal graticule on the oscilloscope face of a new instrument by Hewlett-Packard (11) eliminates reflection. The new model is shown on the right.

General Electric has announced a complete new line of type *AB-30* (a-c) and *DB-30* (d-c) switchboard instruments (12). Instrument features include 1 per cent accuracy, savings from 10 to 20 per cent in costs, and excellent readability.



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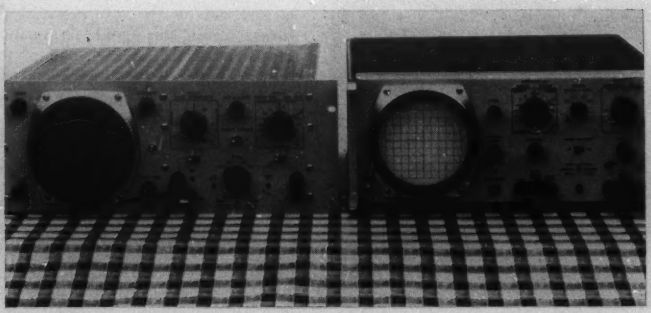

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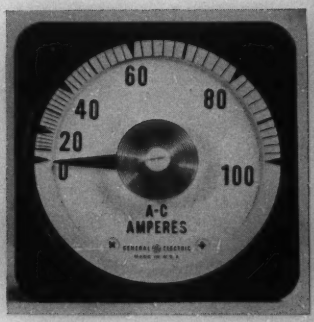

Body function recorder (1), a new medical instrumentation system developed by Minneapolis-Honeywell, makes it possible to monitor the condition of a postoperative patient far more closely than previously practical. Every 2 minutes the system automatically measures and records the patient's pulse rate, respiration rate, temperature, and diastolic and systolic blood pressures. If any of these reaches a danger stage, an audio-visual alarm automatically summons medical personnel.

The National Bureau of Standards has adapted its "peek-a-boo" information retrieval system (2) for direct-viewing search of large collections of documents. The development of a new microcite machine with many automatic features permits a searcher to view abstracts immediately and to reproduce those he finds relevant.

A device developed at ITT Federal Laboratories prints instant, durable captions on negative film (3). The film titler can be used in aerial reconnaissance, map studies, natural resource surveys, and other occupations involving mass film processing.

The Lektrafile automated filing cabinet (4) was recently announced by Remington Rand Systems. The unit provides a system whereby any given record can be brought to reference level within 7½ seconds. A simple push-button panel controls all operations: records carriers move by the shortest route—up or down—to reference position, then stop automatically.

Western Electric Company engineers inspect a computer-controlled

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terminating machine (5) in the automated production line for manufacturing deposited carbon resistors. The gold cathode in the bottom of the bell jar is used to sputter a layer of gold on the ends of the carbon-coated resistor core. This gold termination forms a contact on each end of the resistor, to which the succeeding machine in the line attaches caps and wire leads.

A program is being conducted by the National Bureau of Standards to measure the effects of atmospheric inhomogeneities and turbulence on missile radio guidance systems using microwaves (6). Techniques specially developed for the terrain of the Boulder, Colo., area were employed

to construct an experimental tracking system to simulate the basic functions of the Mistram system being built for the U. S. Air Force.

Rotating beryllium sphere (7), machined to tolerances finer than 15 millionths of an inch, is examined by a Minneapolis-Honeywell scientist using a microscope. The sphere is the only moving part of a radically new gyroscope—free from friction and wear—which permits high accuracy and long life for precise navigation and guidance demands.

Towed at 20 mph, this servo-seismic device (8) developed by General Motors Research Laboratories accurately records the profile of road or airport runway with a response of 0.1 to 15 cps (equivalent to "bumps" 300 feet or 2 feet long). Inertial reference is maintained with an accelerometer–analog computer–servo actuator loop which holds the servo plunger stationary regardless of trailer undulations.

GM Research Laboratories has also developed an automobile radar speedometer (9) based on the Doppler principle. The system is vehicle-borne and is intended to provide speed measurement to the vehicle in those situations in which mechanical contact with the road surface is either unavailable, as in the case of ground effect machines, or undependable, as with slippery roads. The system is similar to the aircraft radar Doppler navigational systems, but is greatly simplified.

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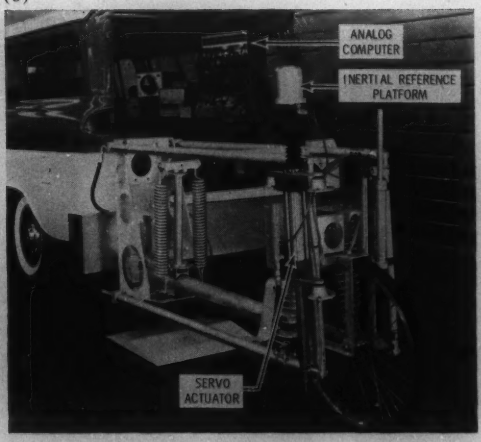

(9)

Transistorized pacemaker unit (1) is utilized for the remote stimulation of the heart by r-f techniques. It provides a 2-mc current over a 1 millisecond interval at a controllable rate of 40 to 150 times per minute. The unit was developed at The Rockefeller Institute in collaboration with the Yale University School of Medicine.

Among the many items of gigantic equipment for General Electric's Project EHV are 750-kv power transformers installed at the system's north and south substations (2). The high-voltage bushings are also of mammoth size, measuring 28 feet from top to bottom and weighing 10,000 pounds.

A transistorized television camera (3) developed for flight into the stratosphere with a 36-inch balloon-borne telescope in Princeton University's Stratoscope II project, is shown in outdoor night tests at RCA's David Sarnoff Research Center, Princeton, N. J.

Adjustments are being made at Armour Research Foundation of Illinois Institute of Technology on an electronic interference monitor (4). This breadboard model of the field-intensity measurement instrument may be used in a satellite vehicle to scan frequencies and record signal strengths. The monitor will determine the effects of interference on the performance of a satellite receiving system.

E. C. Schrom of General Electric's General Engineering Laboratory shows a sample of hard-to-form metals that have been contoured by electrical explosions under water (5). The contoured metal which Schrom is holding looked like the flat sheet in his other

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(2)

(3)

(4)

(5)

(6)

hand before explosion. These underwater explosions (6) are being used at GE in a development aimed at low-cost shaping of hard-to-form metals like titanium, stainless steel, and tungsten. The work is believed to make possible a saving of millions of dollars a year now spent in costly working of these difficult metals. The controlled explosions create shock waves of such force that intricate contours can be blown into the metals in millionths of a second. The new process is expected to have particular significance in manufacturing aircraft and missile parts fabricated of exotic metals which generally are difficult to form by conventional processes.

New "ray gun" (7) shoots words, silently, invisibly, and harmlessly. It was developed by Minneapolis-Honeywell to communicate by transmitting voice signals on infrared beams. Words spoken into the gun are electronically converted into infrared radiation and transmitted to a similar gun-receiver that converts the message back to sound. The technique is said to be effective up to 20 miles.

The U. S. Air Force can translate Russian to English at 40 words per minute with the help of a photographic disk like the one inspected at Eastman Kodak Company (8). Heart of the Air Force translating machine, the glass disks are sent preformed to Kodak where they are coated with a high-resolution photographic emulsion. A vocabulary of 55,000 words is stored on the disk in a channel ⅜ inch in width.

Dr. Henry K. Kolm of the National Magnet Laboratory at MIT (9) is shown with the solenoid magnet in which he produced a continuous magnetic field of 126,000 gauss, believed to be the highest on record. The field was induced in the center of the grapefruit-sized magnet at the center of a water housing when electric current of 10,000 amperes was fed through the rubber-clad cables. The magnet was developed in a program initiated and carried out with Lincoln Laboratory support under Army, Navy, and Air Force sponsorship and was engineered and built by High Voltage Engineering Corporation.

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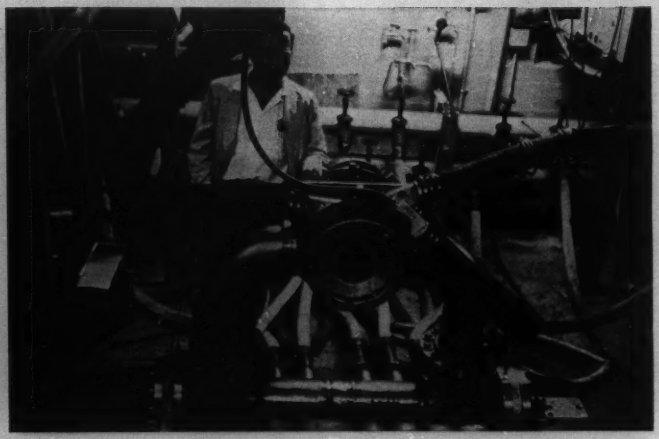

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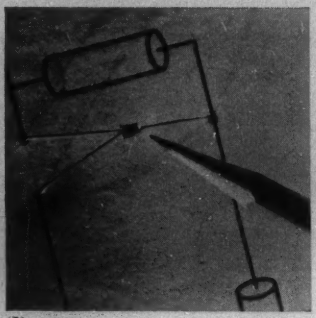

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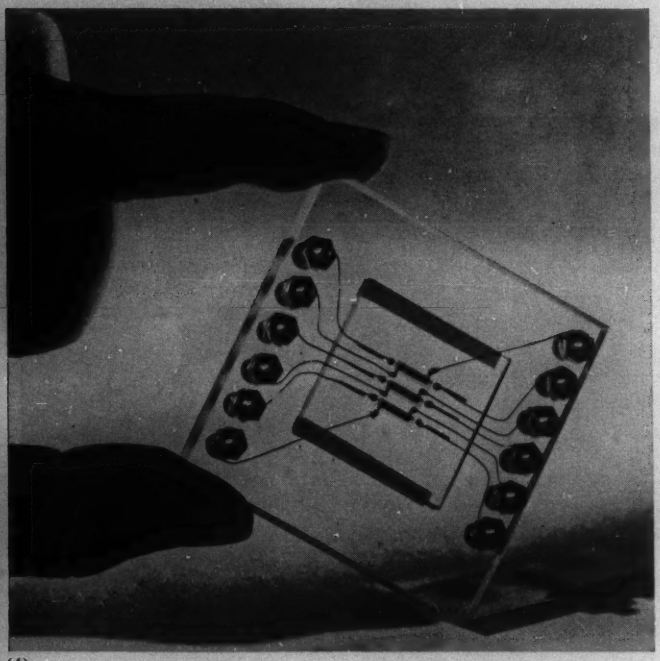

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COMPONENTS

Power output of this GE low-temperature vapor thermionic converter (1) is 23 watts. Efficiency is 16 per cent. Double-ended subminiature silicon transistors by Raytheon (2) permit versatile mounting possibilities. They can dissipate 400 mw at 25 C. Sylvania's hydrogen-filled photoconductor device (3) consists of a cadmium sulfide cell on which electrodes are deposited. Laboratory model of three thin-film transistors (4) on glass base was fabricated by RCA. This type of transistor may help reduce size of computers. Bell Telephone Labs' ultrasonic delay line (5) uses two depletion-layer transducers. A multiple diode for logic circuit applications (6) by Raytheon contains three diodes in a single case. Plasma diode capsule developed by GE (7) may be forerunner of thermionic fuel elements for use with nuclear power stations.

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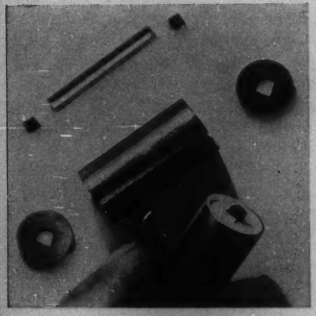

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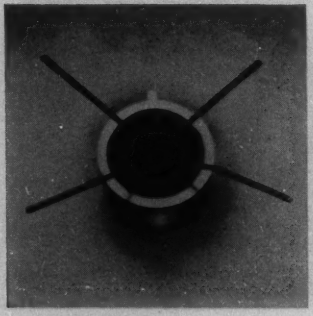

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ENGINEERING PROGRESS

(*Continued from page 916*)

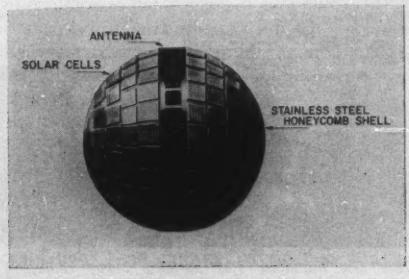
transmitting stations to a central receiving station over toll telephone facilities was announced.

Rapid progress is being made in data transmission via satellite communication systems under government and private industry sponsorship and it is in this field that some of the greatest advances can be expected in the future.

Radio Communication Systems

During 1961, the second site became operational of the BMEWS which linked the Clear Site in Alaska site with the BMEWS Site I in Thule, Greenland. This link-up covers the northern polar wastelands, providing the U.S. with a 15-minute notice of an impending ICBM attack. High-speed electronic processing equipment provides the vital "nervous system" for the huge radar eyes, looking some 3,000 miles into Siberia. A third site is under construction at Fylingdales Moor, Yorkshire, in the northern part of England.

The Clear and Thule sites are connected to the headquarters of the North American Air Defense Command (NORAD) at Colorado Springs, Colo., and the Strategic Air Command Headquarters (SAC) at Offutt AFB, Nebr., by the "rearward" communication facilities. These facilities provide the nerve fiber linking the "eyes" of the free world with the "muscle" of its retaliatory power. It consists of a complex of land and undersea telephone cable, microwave radio relay, and tropospheric scatter transmission systems providing multiple routes to each detection site.



Artist's sketch of Bell System's proposed active satellite repeater Telstar, scheduled for launching in April 1962

The first section (Denver to Salt Lake City) of the Bell System's new *TH* microwave radio system was put in commercial service in March 1961. The Bell System also placed into service its first *TL* microwave equipment which was developed for light traffic route applications. The *TH* equipment initially was installed with one broadband channel (1,860 telephone circuits) each way for telephone, and one each way for protection, with an additional westbound channel for television. The *TL* equipment provides up to six 2-way broadband (6-mc) channels on a single radio path.

A 2-million watt U.S. Navy very-low-frequency communication station went into regular operation at Cutler, Maine, in July 1961.

A world-wide tracing and communications network was completed by the Bell System for the National Aeronautics and Space Administration during the summer of 1961. The network makes use of virtually all types of modern communications.

Several developments of microwave, transistorized (except for an output klystron tube) radio com-

Courtesy of GE

Panoramic view of four detection radar antennas of BMEWS at Thule, Greenland. Situated to give adequate radar section coverage, each antenna is 400 feet long and 165 feet high

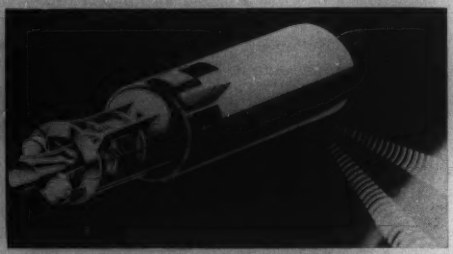
munications equipment were completed during 1961. These meet rigid requirements for either television or telephone service at terminal and unattended relay stations.

An example is the Lenkurt *76A* system. This advanced design microwave system features an all solid-state (except klystrons) radio transmission facility in the common-carrier band of 5,925 to 6,425 mc. The equipment is designed to meet the rigid requirements of color television or 600-channel message operation with regard to phase and amplitude linearity, differential phase and gain, and intermodulation characteristics. These requirements are met through the latest techniques in microwave circuitry.

In achieving the desired high performance for a variety of applications, Lenkurt Electric has established novel techniques in design to advance the microwave transmission art. Among the innovations is a passive waveguide device of extremely small size which linearizes the modulation characteristics of the transmitting klystron. An advanced i-f system also has been designed, comprising a preamplifier mounted integrally with the mixer, a passive filter network to set the i-f bandwidth, and a main i-f extremely broadband amplifier, requiring no tuning

elements. A phase-compensating network equalizes group delay over the i-f band. Other special designs have been used, including r-f filters with controlled phase and amplitude characteristics, and advanced techniques in the limiter and discriminator to provide highly linear operation over a very wide bandwidth.

The type *76A* system is compatible with International Radio Consultative Committee (CCIR) recommendations on frequencies, impedances, levels,



Artist's concept of active relay satellite in which solid-state microwave transmitter and solid-state receiver developed by Sylvania could be utilized within communications satellite network for relay of intercontinental telephone calls, business data, or television programs. Transmitter operates on approximately 2-watt output power within S-band (1,700 to 2,300 mc)

deviation, emphasis networks, etc. A few technical performance figures are furnished to illustrate the capabilities of the equipment: Frequency stability: better than ± 0.02 per cent; transmitter klystron power output: 1.0 watt, nominal; peak frequency deviation: ± 4 mc; tangential threshold sensitivity; -116 dbw (-86 dbm); receiver noise figure: 13 db; baseband frequency response: 0.3 to 3,200 kc, ± 0.15 db; power requirements: a-c operation (115-volt, 60 cps) 2 amperes, 24-volt battery operation 10 amperes, 48-volt battery operation 5 amperes.

There has been progress in the development of atomic clocks. Quartz crystal oscillators have been developed to a high degree of accuracy. Stability of one part in 10^{10} per day, or better, has been achieved. These oscillators, however, require an aging period of several months. This basic defect can be greatly alleviated by locking the crystal oscillator to the center frequency of a stable atomic transition through a servomechanism system. This is the general principle which is used in a gas cell atomic clock.

The atomic transition used in the ITT Federal Laboratories frequency standard is the 0-0 microwave hyperfine transition in the alkali vapors such as sodium, rubidium, or cesium. Optical pumping and optical detection of the resonance permit a very simple circuitry to be used, thus allowing the development of a lightweight, portable atomic frequency standard. This clock can be used as a high-stability frequency standard with more reliability than the ammonia maser or the atomic beam apparatus.

The characteristics of the atomic clock are:

1. Short-time stability—the standard deviation, for measurements of the frequency every 20 seconds, for periods of 15 minutes or more, was 3 to 4 parts in 10^{10}.
2. Resetability accuracy—± 1 to 2 parts in 10^{10}.
3. Absolute accuracy—temperature coefficient: less than 5 parts in 10^{11} per degree C ambient. (at 25 C ± 5 C); magnetic field error: smaller than ± 1 part in 10^{10}.

Because of the expected high reliability of the gas cell frequency standard there are a number of potential commercial applications besides the more obvious military uses. These commercial applications are in the field of long-range navigation and communications.

The National Aeronautics and Space Administration (NASA) has announced its hope of putting the first American in orbital space flight under the Project Mercury program in the near future.

As the Mercury astronaut is hurled into space to circle the earth at a height of about 120 miles and a speed approximately 17,000 miles per hour, his progress will be continuously under observation by a chain of tracking and communication stations linked to Cape Canaveral through the Goddard Space Flight Center near Washington, D.C. The world-

GE's new miniature FM portable 2-way radio, "Voice Commander." Equipment weighs 52 ounces and occupies 88 cubic inches, with transmitter and receiver in a single package

wide tracing and communication network was completed under Bell System leadership and turned over to NASA in July. The network makes use of virtually all types of modern communications—radio and radar, telemetry, telephone, teletype and data transmission.

Space Communication

In the field of space communication, 1961 was primarily a year of decisions affecting the future of satellite communication systems and of preparation for future experiments. Before the Federal Communications System (FCC) were placed the matters of frequency allocations for space communications and plans for ownership of satellite communication systems.

In the field of passive communication systems, NASA is developing an improved Echo II reflector. As part of its Project Rebound, NASA will test methods for launching several of these reflectors with a single launch vehicle. Authorization was given for the launching of orbiting dipoles for experiments by Massachusetts Institute of Technology's Lincoln Laboratories (Project West Ford).

Development is under way on several active satellites to be launched in 1962. These include the project Relay satellite being developed for NASA by RCA, and the Telstar satellite being developed by the Bell System. Arrangements for launching the Telstar satellite call for the Bell System to reimburse NASA for the launching rocket and other launching costs. Plans were also laid by NASA for the launching of the Syncom satellite based on a design developed by Hughes Aircraft Company. This satellite will be launched in an inclined orbit with a 24-hour period and will test the feasibility of maintaining precise orbit periods.

Development work is under way at General Electric Company, Bendix Corporation, and Sylvania on various parts of the U.S. Signal Corps' Advent satellite system. This system will employ "stationary" satellites in 24-hour equatorial orbits. The program calls for the 1962 launching of a prototype design in a low-altitude orbit.

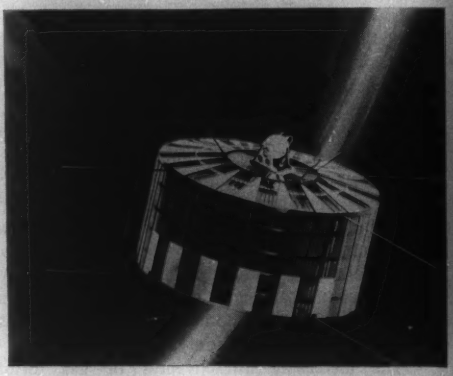
In addition to the development of space hardware for communication satellites, 1961 saw considerable activity in the construction of ground stations for satellite systems and research in devices and techniques for future systems.

GENERAL APPLICATIONS

Aerospace Transportation

A miniaturized short-range transceiver is under development at the Norair Division of Northrop Corporation. New antenna information and near-field information has been obtained which makes a miniature low-frequency design possible. Size, weight, and performance requirements have heretofore limited similar systems to operation in the 20- to 100-mc region. This new low-frequency design provides short-range (200 to 300 feet) voice communications without interference with or by the higher frequencies normally used for communications, telemetry, control, and guidance. The short-range, low-frequency transceivers will link with existing hard-line communications systems to expand the operational capabilities of these conventional communications networks.

A significant advance in the techniques of squib and detonator ignition has been achieved in the development during the year of EBW. Here, instead of depending upon small currents to ignite a sensitive primer which then ignites a detonator, a large capacitor charged to several thousand volts is discharged into a small bridge wire. The resulting release of a large amount of energy in a small volume provides direct ignition of the detonator, giving positive action with simple design of noncritical circuit elements. This is being installed on the Saturn *S-IV* vehicle for stage separation, retro- and ullage-rocket ignition, promising a marked increase in reliability over previous systems.



The white sphere atop the drum-shaped Transit satellite is a radioisotope-fueled SNAP *generator, built by Martin's nuclear division at Baltimore under contract with the AEC. Heat produced by spontaneous decay of plutonium-238 in core of generator is converted directly into electric energy by thermoelectric system*

Signals received from the Navy's Transit satellite, launched June 29, 1961, were transmitted by the first atomic power source to be used in space. The atomic device is a radioisotope-fueled SNAP thermoelectric generator built for the AEC by The Martin Company.

The device is lightweight and compact, about 5 inches in diameter and 5½ inches high. Shaped like an elongated sphere, it has a white coating that increases the ability of the generator to rid itself of excess heat. The generator weighs only 4.6 pounds, but is expected to supply electric power for more than the 5 years during which an operational satellite is expected to function.

In cases of mishap during launch, the fuel containment is sturdy enough to survive the force of an explosion or high-speed impact. The generator has been designed so that heat of re-entry will cause it to disintegrate into particles only about one millionth

of an inch in diameter. The resulting radiation level would be infinitesimal—too small to be measured by existing instruments.

Marine Transportation

The largest diesel a-c electric propulsion system ever built will go into service early in 1962. This 15,000-hp direct-drive synchronous-motor-propulsion system will drive the Navy's 18,000-ton submarine tender *AS-31*. Six supercharged 850-rpm diesel engines will drive direct-connected 2,000-kw generators which will supply power to the single 15,000-hp propulsion motor. Speed control will be accomplished by engine speed control and by sub-synchronous operation at very low speeds.

The extreme flexibility of a multiple prime mover electric drive system is particularly valuable on a submarine tender, since the propulsion generator sets can be used to augment the normal ship's service power system when the vessel is performing its primary function of servicing and replenishing nuclear-type submarines. The four 750-kw ship's service generators, also diesel-driven, are equipped with static excitation and static voltage regulating systems, as are the 2,000-kw propulsion generators when used for ship's service power duty.

The increasing attractiveness of gas turbine-driven generating sets for shipboard use has led to the sponsoring by the U.S. Maritime Administration of the installation of a 600-kw unit on the SS *Pioneer Moor*, operated by the United States Lines. The purpose of this trial installation is to explore the technical feasibility and advisability of utilizing a gas turbine-generator set as a source of electric power for all port electric loads during periods when steam necessary for the operation of the normal ship's service generators is not available, or when for reasons of economy it may be desirable to secure the ship's main boilers. The unit is arranged with a waste heat boiler to generate steam from the turbine exhaust gas so that normal in-port steam needs may be provided.

Significant improvements in marine group control now permit the use of 12-inch deep structures for ship auxiliary drives of National Electrical Manufacturers Association sizes 1 to 5, and require no access from the rear. Traditional group control structures have been 21 inches deep and have required additional floor space for rear access during servicing and installation. Motor starters, distribution panels, and other equipment may be included to provide factory-wired, easily accessible structures requiring minimum deck space in engine rooms, refrigeration, ventilation, and deck machinery spaces. These structures may be back-to-back mounted and smaller assemblies can be bulkhead mounted, if desired.

View of 600-kw gas-turbine-driven ship's service set installed on SS Pioneer Moor

INDUSTRY

Cement Industry

The principal engineering developments in the cement industry during 1961 occurred in the direction of lowering cement manufacturing costs by increasing use of automatic control techniques—automation—and increasing emphasis on modernizing facilities to use larger, more efficient process work units.

Ball mills driven by five high-torque 2,500-hp synchronous motors of 200 rpm, 4,600 volts, and 1.0 power factor

Illustrative of this trend toward increasing emphasis on more automatic control of the cement-manufacturing process is the installation during 1961 of several continuous X-ray chemical analyzers to provide continuous information on the quantitative chemical elemental content of calcium, aluminum, silicon, and iron. Many other process sensors are finding increasing use.

The Cement Industry Committee during 1961 contributed to these, and many other less spectacular but equally important, engineering developments in the cement industry by the production of several timely and appropriate technical papers in the areas of maintenance and safety, drives and related products, distribution and related products, and automation. These papers were all presented at the April 1961 Third AIEE Cement Industry Technical Conference in Detroit. Their scope ranged from recommended practices in each of the areas to covering specific aspects related to each of the particular

areas. The effect intended, and to a considerable degree achieved, is to increase understanding of basic electrical engineering principles on the part of cement manufacturers and those who supply electric equipment to the manufacturers.

Chemical Industry

Electrochemical Processes Subcommittee

The most important activity of this subcommittee resulted in the "Subcommittee Report on Electrical Characteristics of Electrochemical Cell Lines" which included the first comprehensive information on inrush currents, decay voltages, cemf's and cell line impedances. One conclusion of the report was that separate polarizing means are generally not needed to limit the inrush current and the duty on the power-conversion equipment. This means an appreciable saving to the user. Also, the range of the voltage-regulating equipment need be chosen only with reference to the requirements of the process or its operation, and not to reducing the duty on the conversion equipment like, for instance, semiconductor rectifiers. The report contributes to a better understanding of the application of switchgear and rectifying equipment to electrolytic cell lines.

Corrosion and Cathodic Protection Subcommittee

The use of cathodic protection has continued to grow; among the more important new applications was an installation at the new Pier No. 40 in New York City, which is probably the largest single cathodic protection system ever installed. It is intended to prevent corrosion on the submerged surfaces of more than 3,000 H piles supporting the pier. The system has a capacity of 8,500 amperes supplied by 27 rectifiers, each rated 320 amperes, which are connected to more than 1,300 graphite anodes suspended in the water below the pier.

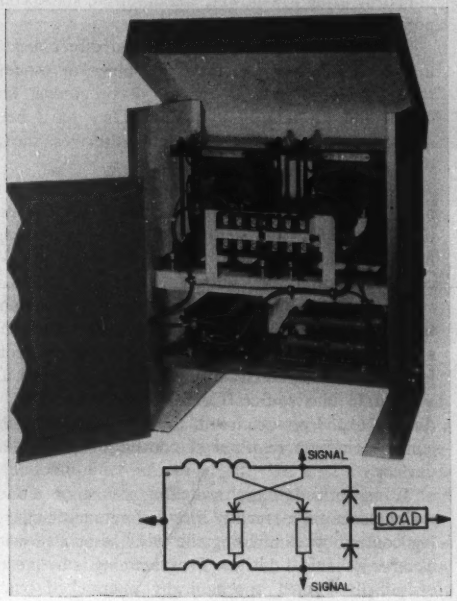
Battery Subcommittee

Considerable progress has been made in the application of fuel cells, particularly of those using low-cost hydrocarbon fuels for reasonable economy. In military applications weight reduction has been more important than operating economy or first cost.

In satellite batteries, efforts are being made to develop reliable seals to prevent electrolyte loss and consequent failure. For this reason, metal–ceramic enclosures are being developed. These batteries are charged by high-efficiency solar cells in a relatively short time.

Industrial Control

An automatic gauge control system has been applied to a stainless steel continuous hot strip mill at the Midland plant of the Crucible Steel Company of America. Gauge control is obtained by means of optimum-response electrohydraulic servo-type screwdown positioning systems with roll position compensation on stands two and four, and adjustment of the tension setting of the hydraulically actuated looper between stands four and five. Gauge variation is measured by roll force transducers on stands two and four and an X-ray thickness gauge at the delivery end, and controlled by computer-quality transistor operational amplifiers, static transmission gates, and transistor logic elements.



Courtesy Square D Company
New static power amplifier features high efficiency and fast response

A simple and accurate regulating system for controlling the speeds of sectional paper machines or for other similar applications has been developed. The feedback signal is a drift-free digital signal obtained from a Pulstac coupled to the motor shaft. The pulse signal, which is proportional to actual master speed, is converted to an analogue signal and compared to an accurate d-c voltage reference. The error signal is then amplified through a high-gain operational amplifier to a Trinistor amplifier for controlling the shunt field excitation of the generator or motor. The regulating system limits steady-state speed errors to less than ± 0.1 per cent of rated machine speed.

Amplifiers, utilizing Trinistor controlled rectifiers, are replacing magnetic and rotating amplifiers in a wide range of industrial regulating systems, where the high-power capability and high-power gain with low time delay provides a new flexibility.

Low input power requirements eliminate the need for preamplification in many applications and, in complex systems, permit sophistication to be ob-

tained by using low-power, standardized, static components.

Trinistor amplifiers have permitted direct excitation of the large main drive machines of tandem rolling mills as well as control of processing line drives and tin reflow equipment. They have been applied to paper winder and sectional drives, shovel drives, and synthetic fiber spinning.

A unique static power amplifier incorporating the most desirable operating characteristics of conventional saturable core reactors and self-saturating magnetic amplifiers has been developed for a-c and d-c controlled power applications.

The amplifier has exceptionally high electrical and thermal efficiency. Its modular construction minimizes spare part inventories and installation problems. Self-contained circuitry eliminates the need for a separate bias source. Control signals are applied directly to the power circuit, thereby eliminating the control windings required of conventional magnetic devices.

Transistorized static switching elements reduce maintenance on a recently installed automatic charging control by eliminating the wear associated with electromechanical devices. Programming is by means of self-illuminated, mechanically interlocked push-button matrices.

All sequencing between the skip hoist, the large and small bells, the distributor top, and the stock rod hoists is performed by static switching devices, thereby eliminating the large rotating cam stepping switches previously used. The system is adaptable to punched card programming and is designed to allow the addition of computer programming at a later date.

Mining Industry

The year 1961 has been another year of progress for the mining industry—progress in the form of new products to enhance the safety, efficiency, and economy of mining operations.

New highs have been reached in the ratings of open-pit mining machinery. A giant 115-cubic-yard shovel is being built for Peabody Coal Company by the Bucyrus-Erie Company. This shovel will use the first of a complete line of static Trinistor regulators designed to control the 18,000 hp of d-c motors driving the shovel motions. This control system is expected to make obsolete previous methods of controlling the smallest to the largest excavators. A dragline of 90-cubic-yard capacity is being built by Marion Power Shovel Company, also for Peabody Coal.

For underground mining, a hermetically sealed mine power center transformer using C_3F_8 gas (perfluoropropane) instead of nitrogen has been developed. This new gas allows a 15 per cent reduction in size and weight, gives a full-wave impulse level comparable to oil-immersed apparatus, and obviates a need for special lightning arresters formally required on dry-type transformers—all in addition to the low maintenance, inherent ruggedness, and moisture- and dirt-resistant construction, long associated with the nitrogen sealed unit. These new smaller and lighter C_3F_8 mine transformers, available in ratings above 300 kva and 5-kv voltage, facilitate the frequent moves required in underground mining.

Two adjustable voltage mine hoists installed at the Christmas Mine of Inspiration Consolidated Copper Company feature automatic programming of operation. Riders may control the service hoist from push buttons on the cage. The control of intelligence is transmitted 1,750 feet (ultimately 3,000 feet) up the hoist rope by means of a pulsed frequency-shifted carrier signal. Manual control is available for emergency operation.

The advent of the silicon rectifier for mining service has all but made obsolete other methods of power conversion. Easier maintenance is featured by the lighter, smaller, more efficient silicon units.

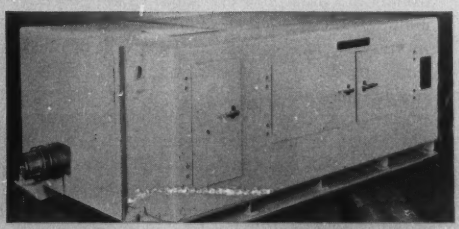
As in the past years, co-operation of trade groups and manufacturers with the U.S. Bureau of Mines has resulted in developments and recommendations in mine safety.

Petroleum Industry

The major fields of interest in the petroleum industry are manufacturing, production, and transportation. Each of these fields experienced engineering developments of noteworthy interest during the year, associated with the application of new techniques in broader system concepts.

In the manufacturing area, which covers petroleum and petro-chemical processing, the increased use and acceptance of computer control and electronic instrumentation systems stand out as the major developments. For the first time, these systems are being engineered into new plant construction as an integral part of the process units. The problems of integrating these equipments into existing plants are bringing about a closer working relationship among engineers in these industries.

In the production area, which covers exploration and production of oil and natural gas, developments are concentrated in more extensive use of electric



Courtesy Westinghouse

Mine power center with C_3F_8 sealed transformer

power and advanced instrumentation systems. Packaged electric-powered drilling rigs have shown continued growth. The automation of off-shore production is continuing to receive attention as a more economical method of dealing with unique problems in this area of the industry.

In the transportation area, which covers movement of crude, oil, natural gas, and products, pipeline automation is receiving the major emphasis. The use of digital computers for dispatching and simulation operations is being implemented for the first time as an accepted method of control. This is made possible by the increased acceptance of remotely controlled and operated pipeline systems. More reliable equipment in the form of transistorized supervisory control and digital telemeter systems has made the concept a reality and future years will see further movement in this direction. One aspect of interest to all areas of the petroleum industry is the use of new lower power devices for control. This development offers the possibility of intrinsically safe devices designed for application in classified areas. The development of standards for these devices is already under way.

INSTRUMENTATION

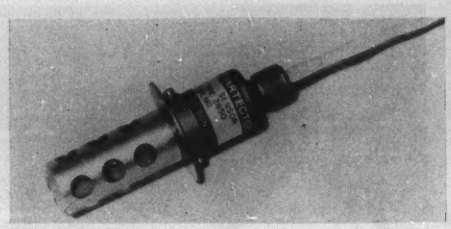
Aerospace Instrumentation

Recording and telemetering requirements indicate the need for transducers having digital outputs. Rpm and flow-rate transducer outputs are easily convertible to digital code, but acceleration, temperature, pressure, electrical quantities, vibrations, and strain measurements are not so easily converted. It has been suggested that transducer manufacturers start programs which will culminate with transducers having digital outputs.

Missile re-entry studies require transducers for the measurement of ablation. Four acceptable techniques have been developed:

1. A radioactive isotope distributed through the thickness of a nose cone section ablates, causing a reduction in the radiation intensity. Suitable sensors inside the missile measure the decrease in radiation and, hence, the amount of ablation.
2. A grid of parallel resistors embedded in the nose cone wall increases in resistance as the nose cone ablates and open-circuits the resistors in sequence.
3. Sound pulses generated by a piezolectric crystal inside the nose cone are reflected by the outer surface and returned to the generator where another pulse is created. The sound repetition rate is inversely proportional to the material thickness.
4. A semiconductor is mounted in the nose cone surface in such a way that its resistance increases as it ablates with the nose cone.

A simplified analog-to-digital converter using capacity charge transfer has been described by C. W. Barbour of the Towson Laboratories. Only a reference d-c voltage, three identical capacitors, a switching sequence, a comparator, and unity-voltage-gain amplifier are involved. The first capacitor is charged to the reference voltage E. The second capacitor, momentarily connected to the first, receives one-half the charge. The second capacitor is momentarily connected to the third through the amplifier in such a way that its charge is completely transferred to the third capacitor, at which time the third capacitor voltage is $\frac{1}{2}E$ and the amplifier output is $\frac{1}{2}E$; hence the voltage increment to the third capacitor is $\frac{1}{4}E$. Each successive sequence provides a voltage change of one half the preceding change, which fits into the binary number system. The capacitor senses whether the amplifier output is greater or less than the analog. With amplifier output less, the switching is such that the values of voltage are added, but if greater, they are subtracted. The direction in which the first charge is applied to C_3 determines the polarity of the signal. Succeeding increments (in the same direction) represent binary "ones" and decrements represent binary "zeros."



Point level sensor by Trans-Sonics, Inc., for liquid oxygen and liquid hydrogen applications. Quartz crystal of level probe in electric oscillator circuit having constants that cause oscillation to occur if quartz probe is in a gas but not when touching a liquid

Progress has been made in sensing the telemetering of physiological data. Reduction in the size and weight of the telemetering units has made it much more convenient for data to be obtained on men in air-borne and space vehicles. The physiological factors which have been covered included brain waves, heart action, respiration, and body temperature. Work has been done on blood pressure but the sensors for this are less convenient for the subject to wear than the other sensors.

Fundamental Electrical Standards

The unit of electrical resistance is maintained by the National Bureau of Standards (NBS) with a group of highly stable 1-ohm standard resistors. Values assigned to these standards are based upon so-called absolute measurements of resistance. In these measurements a resistor is compared with a computable inductor or capacitor using a current which varies periodically at a precisely known fre-

Gauge bars used to form NBS computable capacitor

quency. The value of the inductor or capacitor is calculated from its mechanical dimensions. The value of the resistor used in the absolute measurement is thus determined in terms of length and time units.

Capacitors are inherently better circuit elements than inductors because they may be made relatively loss-free and may be completely shielded. Until recently, however, computable capacitors could not be constructed with an accuracy equal to that of the best calculable inductors.

Thompson and Lampard introduced a theorem in electrostatics and its application to calculable standards of capacitance, which was published in *Nature*, vol. 177, 1956, p. 888. This made possible the design of capacitors whose values can be calculated within a few parts per million (ppm) in terms of a single dimension. With the theorem, R. D. Cutkosky and co-workers in the NBS have constructed a computable capacitor, using 1-inch diameter gauge bars, having a nominal value of 1 picofarad. The exact value of this capacitor is known to a high order of accuracy. By means of accurate step-up procedures, a 10,000-picofarad capacitor can be evaluated in terms of the 1-picofarad standard. With the use of this larger capacitor in a new frequency-dependent bridge, a value may be assigned to a 10,000-ohm resistor in terms of length and time units. This resistor is then in turn compared with the 1-ohm standards used to preserve the unit of resistance. The results of this work indicate that the NBS unit of resistance differs from the ideal absolute unit by an amount which probably does not exceed 5 ppm. For further information, see "An Evaluation of the NBS Unit of Resistance Based on a Computable Capacitor," *Journal of Research*, NBS, vol. 65A, *(Physics and Chemistry)* no. 3, 1961, p. 147.

Indicating and Integrating Instruments

In December 1941, the Indicating and Integrating Instruments Committee issued "Progress in the Art of Metering Electrical Energy," which has become the official AIEE document concerning the history and development of the electrical metering art. Last year, a committee was appointed to bring this publication up to date; the revision is nearly ready for publication.

Two new network meters, departing from the single-stator design introduced a few years ago, are of 2-stator type, but simplified by the elimination of the conventional light-load and full-load adjustments. Meters without adjustments are a result of the advancement in the art of building watt-hour meters, in that the material and workmanship are such that the calibration remains permanent for long periods. A var-hour meter which does not use phase-shifting transformers was introduced.

Inasmuch as loads are increasing and are often serviced by more than one circuit, industry has redesigned some of the mechanisms used for totalizing metering in view of its greater importance. One of the recent developments is a pulse-type mechanism designed to eliminate contact maintenance and to result in a more reliable piece of equipment.

Feedback Control Systems

During 1961, at AIEE technical meetings and at the 1961 Joint Automatic Control Conference (JACC) significant emphasis was placed on those control systems in which automatic means are used to change the system parameters. This is usually done in a way intended either to improve system performance or to optimize some system variable; consequently these systems have been characterized as "adaptive" or "optional." Also on the theoretical side, it is to be noted that technical inquiries into the stability methods of Lyapunov have persisted.

The tailoring of materials such as silicon to perform electrical functions without the use of conventional components and wiring techniques will initiate trends in the more sophisticated control systems and other electronic devices. Tailored functional electronic modules already exist for amplifiers, oscillators, multivibrators, switches, pulse generators, etc.

Feedback control system techniques have continued to be applied in many interesting ways. Typical examples involve the Electric Autolite Company, Socony Mobil, and Phillips Petroleum. Electric Autolite runs an Alabama manufacturing plant from its Ohio headquarters by means of a digital computer and connected data linkage so that management and operating functions as payroll, general accounting, production scheduling, inventory control, and materials planning are accomplished on a current

basis. Socony Mobil has tied its New York computer to a refinery in Texas, and research centers in New Jersey and Texas and will expand this computing capability to cover its facilities throughout the country. The computer will make decisions, taking into consideration that crude oil comes from many fields and may go to different refineries from which a variety of end products flow to as many as 10,000 markets. The computer selection of the refinery involves operating factors, transportation methods and rates, and individual costs and other restraints needed for planning product flow. Phillips Petroleum has used a computer for the on-line control of a thermal cracking furnace in Texas. Involved in this feedback control system are over 20 process variables and associated data-processing equipment to convert data to the form required by the computer and the process.

Simulation of feedback control systems was accomplished on analog or digital computers. Where the simulation has required memorizing system variables, a digital computer has usually been required. It appears, however, that new computer types are being offered that have the ability to follow iterative procedures. These new types will fill a significant gap where high-speed data processing is paramount but where costs may not be ignored.

A phase-angle master standard that is accurate to 0.01 degree at 400 cps has been developed at NBS. It is used to calibrate phase-angle meters and phase standards. Such devices are of increasing importance in missile guidance and other applications. The new standard consists of a π-section line made up of fixed sections and an adjustable section to provide known phase shifts up to 180 degrees. The phase shift of each section can be computed from the inductance and can be checked experimentally.

A 5/5-ampere standard current transformer and comparison circuit were designed and tested at NBS to provide a basis for establishing ratios of alternating currents to a few parts per million at frequencies of from 60 cps to 10 kc. The transformer, first of a series, has a unique winding formed from copper strips placed edgewise around a high-permeability core.

Telemetering

The unsatisfied desire for higher degrees of accuracy in the transmission and accumulation of large amounts of data, was partly responsible for the increased attention devoted to the use of digital techniques. Advances in these techniques were made largely in connection with flight-testing instrumentation involving air-to-ground transmission of information.

It is evident in the more sophisticated systems, where the operational flexibility of digital techniques is employed, the telemetering link is so closely interwoven in the entire system, and the components so interdependent, that it is becoming more difficult to consider the telemetering function alone. Too often it is tailored to meet the requirements of specific systems with very little effort directed toward existing telemetering standards already available.

With the ever increasing use of pulse code modulation, systems using it are receiving widespread attention. Several improvements in synchronization to reduce malfunction and increase usable bandwidth are recorded in the literature.

The present man-in-space programs, of necessity, have done much to stimulate interest in biomedical telemetry. Systems have been developed which will transmit as many as six physiological parameters simultaneously. Already efforts are being directed toward the practical applications of these systems in industry and hospitals where other than ideal laboratory conditions exist. Applications of digital telemetering used in conjunction with oceanographic research are finding their way into the literature because of increased interest in automatic data acquisition in this field.

POWER

Insulated Conductors

The Cornell Extra High Voltage Cable Field Testing Project sponsored by the AEIC, the EEI, and the manufacturers entered the actual cable-testing phase in April 1961. Four complete cable systems are under test. Two of the systems are of the pipe type but differ from one another in the construction of the conductor and treatment of the insulation. A third system uses low-pressure, oil-filled, self-contained lead-covered cable, and the fourth is a high-pressure self-contained oil-filled cable in aluminum sheath.

Start of the testing phase of the program coincided with the convening of an Extra High Voltage Cable Conference at Elmira, N. Y., April 11-13, 1961, under the sponsorship of the AIEE Insulated Conductors Committee. Attendance included 57 foreign engineers as well as 135 American cable engineers. The 11 papers, outlining various aspects of the project, are available in a 232-page report, AIEE Publication T-129.

The field test is scheduled for a 3-year period. The first 2 years of testing will serve to evaluate the service aging of the 345- to 400-kv cable systems as a measure of their acceptability for power systems in this country. The cables will be subjected to 345 kv (1 month), 380 kv (1 month) and 415 kv (20 months) and circulating current will raise and maintain conductor temperatures either continuously or as a cyclic load corresponding to loads of 500- to 600-mw at 345 kv.

The third year will be used to explore the probable limits of these cable systems at higher voltages and conductor temperatures. The cables will be subjected to 415 kv (6 months) and 450 kv (5 months) and to conductor temperatures, obtained by continu-

ous or cyclic loading, corresponding to over 600 and 700 mw at 345 kv. Finally, during the last 3 months, the voltage will be raised to about 500 kv—limit of the test transformers—under loading conditions comparable to those used during the first 2 years.

The tests so far indicate that the American cable manufacturers have succeeded in making cables for 345- to 400-kv service which have low initial insulation losses and which are quite rugged. By the middle of 1963 the first mile post of the Cornell cable testing will have been reached and by the end of 1964, the scheduled completion of the test, valuable experience will have been gained in the operation of 345- to 400-kv underground cable lines.

Power Generation

Two large new generating stations were operated this year by computer control: Huntington Beach of Southern California Edison and Little Gypsy of Louisiana Power and Light. The computer control systems at these plants accept approximately 1,000 analog and digital signals from the plant and initiate a start-up or shutdown. The start-up or shutdown actions of opening valves, starting motors, etc., is monitored and sequenced by the computer system. These two installations are the first automatic start-up plants in the world.

With the installation of more and larger thermal power plants, hydro stations are no longer the source of total energy supply. As a consequence they are now of minor importance in the power industry; however, there is increasing use of hydro as a means of providing peak power to take the high loads which generally come at the close of the working day. (There is a large variation in the use of electric power during the 24 hours of each day and an electric system must consequently have more than enough capacity to meet any peak load.)

Not only do regular hydro power stations provide peak power, but multipurpose dams for irrigation and city water supply are being harnessed too. One reason for the new attention to hydro for peak power is the improvement of the reversible turbine that can be driven to pump water back into the upper reservoir during periods of low demand at night and on Sundays and holidays, then be allowed to run forward to generate electricity during the periods of great power demand. About 2 kw are recovered for every 3 expended in the pumping process.

This concept of pumped-storage is not entirely new; Europe has about 2¼ million kw of such capacity and the U.S. half of that amount, with about 2 million kw planned and under construction. The site of the new projects need not necessarily be along rivers; any source of water supply with a rise in the surrounding land of about 300 feet containing several acres for the storage reservoir could be a means of cost cutting as the water flows back downhill over the turbine blades in the power station to its source.

Power System Communications

Developments in communications for the power field have largely been related to transistorization of equipment and developments surrounding application to higher voltage transmission lines. Much has been accomplished in transistorizing pilot relay and other types of carrier-current control equipment. The use of this type of equipment resulted in solving many problems concerning their application in substations where transient voltages were more damaging to static devices than previous vacuum-tube designs. The industry has gained knowledge in the application of this equipment and discovered several problems yet to be solved. This will be the subject of continuing work by AIEE committees.

Accompanying the transistor designs, ways have been developed to provide narrow bandwidth in carrier-current channels in order to allow application of more equipment in the present spectrum.

Developments have started in the utilization of insulated ground wires as a transmission medium of carrier-current channels. Several projects were tried out by the electric utilities with success and additional developments are expected in connection with ehv lines.

The AIEE Power System Communications Committee worked in the preparation of the "Methods of Measurements Report and Equipment Standards," which will be a great aid to the industry in the evaluation of carrier-current channels on transmission lines and the evaluation of noise on existing circuits as well as on many of the proposed ehv lines.

Rotating Machinery Committee

A tandem-compound turbine generator unit has been put in service at the Arkansas Power and Light

First commercial 25,600-kva turbine generator with harmonic excitation. Elliott Company development eliminates rotating exciter; power derived from harmonics of main generator flux wave and special stator winding. Harmonic excitation control housed separately

Company. This 3,600 rpm Westinghouse generator is rated 384,000 kva, 0.85 power factor at 45 psig hydrogen pressure and has a capability of 422,400 kva at 60 psig gas pressure. Manufacturing has started on a 460,000-kva, 0.80 power factor at 45 psig hydrogen pressure for the Texas Electric Service Company.

The first 2,500-hp synchronous motors equipped with brushless excitation systems have recently been manufactured by the General Electric Company. D-c excitation is supplied by the rotating armature of a small 3-phase a-c generator mounted on the motor shaft and wired directly through silicon-control rectifiers to the motor field winding. A small box containing solid-state control circuits is mounted on the rotor. This control device short-circuits the motor field winding during starting, applies excitation when synchronizing speed is reached, and removes excitation if the motor pulls out of step.

High-potential testing of windings of large high-voltage machines at very low frequency is making it possible to conduct such tests with lightweight portable equipment. Testing at 0.1 cps rather than 60 cycles reduces by 600-to-1 the required kva.

A generator used for testing circuit breakers has been developed by General Electric. The generator is able to deliver 1,000 mva initially on a symmetrical 3-phase short circuit. A novel method is used to block the stator coils rigidly against the extremely high forces caused by short-circuit currents.

The world's largest reversible generator–motors are now under construction at General Electric's Large Motor and Generator Department in Schenectady, N. Y. Two units each rated 204,000 kva, 240,000 hp will be installed at Union Electric Company's Taum Sauk Pumped Storage Project.

Substations

Substation insulation and electrical clearances required for voltages of the order of 500 kv and over were under study in many places during 1961. Studies included laboratory tests and actual substation installations in connection with both test line sections and operating lines. Problems of corona and RIV from substation bus and equipment, and mechanical problems resulting from the greater electrical spacings, were also studied.

Use of aluminum bus has continued to find more general application. Use of aluminum for substation structures has become more extensive, though steel structures still predominate.

New supervisory systems have been developed and old systems modified to provide for remote-data logging as an integral part of the system. The trend is to automatic data logging and away from manually selective telemetering. Supervisory systems have been developed using semiconductor devices instead of relays or telephone selector switches.

AIEE working groups have been actively studying problems of ehv substations, including electrical clearances, aluminum bus and structures, designs of substations for community acceptance, and standardization. Committee work on "Safety in Substation Grounding" was completed with the issuance of AIEE Publication no. 80.

Mobile substation of 7,500 kva has two trailers designed and built by Westinghouse for Florida Power & Light Company. Transformer rated 115 kv on primary and 4,160 × 13,800 × 24,000 volts on secondary

Switchgear

During the past year, gas-filled circuit breakers utilizing sulfur hexafluoride as the interrupting medium were developed for the subtransmission voltages of 34.5, 46, and 69 kv. In this breaker 3-phase pole units are contained in a single tank. The interrupting gas is stored at a pressure of 220 psig and blasted into the interrupters. It is then discharged into the low-pressure region of the tank which is maintained at 40 psig for good insulation. Two interrupters per phase are used and one blast valve is provided for each pair of interrupters. The

A 69-kv 5,000-mva 2,000-ampere circuit breaker

breaker is closed by a single pneumatic mechanism and opened by springs. The blast valves are operated mechanically from the breaker linkage. A cabinet on the end of the breaker is provided for the high-pressure gas storage tank, gas compressor, and associated controls so that each breaker unit is self-contained with all of its associated equipment. High-pressure gas storage is sufficient for 4-breaker interruptions before lockout.

During 1961, a line of outdoor air switches utilizing aluminum current-carrying parts was introduced for the range of transmission voltages of 115 through 161 kv. These switches are assembled on new high-strength 3-inch-bolt circle insulators made from alumina porcelain. The switches are assembled on extruded aluminum bases. The use of aluminum for current-carrying parts and bases and the use of the high-strength alumina ceramic in the insulators has made possible a 45-per-cent weight reduction in the switch units. The reduction in size and weight makes possible significant economies in switch applications for this range of transmission voltages.

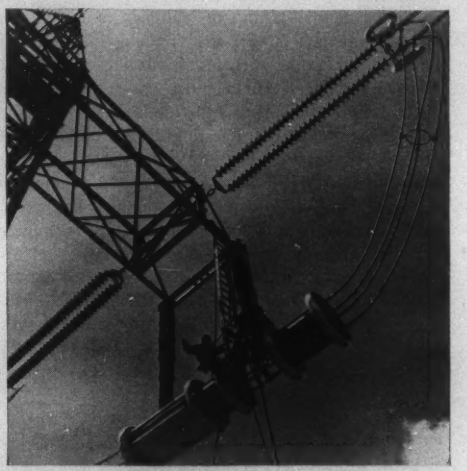
System Engineering

For reports to EEI (Edison Electric Institute), etc., many electric utility companies now keep operating records of several items including the forced outages of generating stations. With only a few additional items, this information can provide the fundamental basis for determining the probability of outages in generating stations. This information would be more valuable if all companies would record it in the same manner. A form for this purpose has been developed and presented with the hope that it will become the standard. Several companies are now using it, and it is hoped that many more will adopt it to receive the benefit of this information. The greater the number of companies using the form, the more valuable each part of the information becomes.

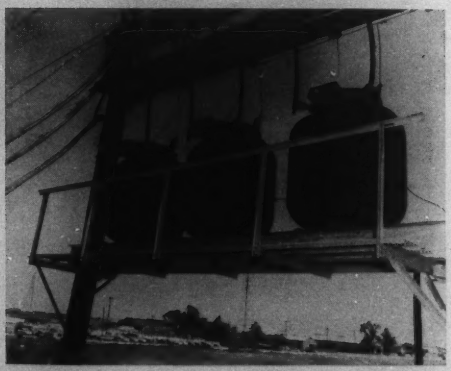
In the past years there have been several individual developments of equipment for the automatic control of the production and distribution of power. Naturally, each development would make use of terms and expressions for describing the power system operation and the elements of control. To compare the various systems and to avoid misunderstandings, it became obvious that a standard terminology should be developed. As a result of considerable work and numerous discussions and reviews, this terminology standard is practically complete and ready for presentation and publication.

Transmission and Distribution

Ehv projects in the U.S. and Canada continued to claim the limelight during 1961. At the high altitude (10,500 feet), 1-mile line of the Public Service Company of Colorado, corona and radio measurements were made of the various conductor configurations. The 13-mile line of the Pennsylvania Electric Company carrying power at 460 kv was studied, particularly for its radio noise and lightning flashover characteristics.



Decoupler for isolating RI measurements on 750-kv Apple Grove line



Three 500-kva, single-phase, 7200/12, 470-Y to 240/480-volt transformers installed by Houston Lighting and Power Company to provide service to new Cook Heat Treating Plant, Houston, Tex. Transformers supplied by Westinghouse are mounted on 18-foot rack, 20 feet off ground

The Pittsfield, Mass., ehv line of the General Electric Company continued to produce appreciable electrical and atmospheric data for analysis by computer. Studies were continued up to 750 kv.

The newest line to be energized was the Apple Grove, W. Va., project of American Electric Power, Westinghouse, and six other leading manufacturers. The unique feature is the arrangement of three separate lines, ½ mile each, radiating from a central substation and allowing simultaneously RI and corona

Automatic inspection station plays significant role at Western Electric Company's North Carolina Works in automated manufacture of deposited carbon resistors. Feedback control and self-correction of helixing machine cuts spiraled groove in carbon film to give precise resistance, based on computer-controlled analysis of values inspected here. Defective resistors are indicated on visual monitoring graph and automatically rejected

loss measurements on three different conductor configurations, each carrying heating current to simulate line loading. A newly developed decoupler isolates the RI measurements on the three spurs. The line was first energized on June 22, 1961, at 775 kv.

The experimental studies on the 460-kv Cold-water line of Hydroelectric Power Commission of Ontario, Canada, were completed during the past year. As a result, the proper information was obtained that permitted the design of a 500-kv, 4-bundle conductor line, the first 230-mile section of which was to be started before the end of the year.

Interest continued to grow in the use of the "bare-hand" technique for making changes and additions on energized high-voltage lines. First introduced by American Electric Power through H. L. Rorden, a Transmission and Distribution Committee member, actual transmission line work was carried out on lines energized up to 345,000 volts. Leakage current measurements of the insulating boom under adverse weather conditions supplemented by laboratory studies afforded a measure of the safety precautions needed.

SCIENCE AND ELECTRONICS

Computing Devices

Fast-moving developments in the computer field continued in 1961, with a variety of improvements, and notable technical advances. Parallel processing of information, multiple input/output channels with facilities for real-time connections with remote points, hierarchies of memories with different speeds and novel ways of addressing them, and faster units of peripheral equipment constitute the principal hardware features in this advance.

The STRETCH computer set a new high as to size, but complexes of computers began to appear as well. These include hybrid analog-digital systems in closed-loop configurations. All through the scale of sizes, expanded memory capacity appeared with the highest memory speeds limited to small portions of the total storage. For mass memory, the trend is toward large disks. A novel storage device, using magnetically coded card records which are mechanically selected by means of notched edges and automatically read and returned, made its appearance. Miniature computers gained prominence. Several powerful computers having a volume of about 1 cubic foot were announced, and one firm announced plans for making a compact pneumatic computer.

Fast circuit techniques came into use through thin magnetic films in computer memories, and tunnel diodes in large equipment. Layers of cryogenic thin-film memory plans were produced experimentally during the past year.

Common language compilers gained support during the year. Indirect addressing and associative memories in which stored information is found by reference to its contents made their appearance. For mathematical operations, the Polish notation gained attention; with it, program steps are written rather simply with standard algebraic signs. Executive routines, and a stored logic feature in which the logic of the system can be changed by the program were featured in computers which made their appearance in 1961.

An information retrieval system was demonstrated in which any one of about 100 million documents in a microfile can be located in less than 5 seconds.

The prevalence of computers in universities increased in the United States and Great Britain; most Canadian universities now have computers.

Attention to computers for industrial control became intense. The largest electrical manufacturers made working agreements with computer firms or established internal capability in this field. Logging and monitoring applications were the most usual in the control field. Machine control applications increased and some fabrication and process control installations were completed. Dynamic control of chemical processes has begun and the first installation of on-line economic load dispatch of electric power occurred this year.

Automation of computer production is prevalent; at least three major manufacturers have introduced automatic wiring of panels under the control of punched cards or tapes.

Standardization efforts in the computer field are quite active. A notable change is the replacement of the National Joint Computer Committee sponsored by AIEE, IRE, and ACM by a newly founded federation of societies called AFIPS. Membership in this federation is also open to other societies with data-processing interests.

IBM scientists P. P. Sorokin (left) *and M. J. Stevenson shown preparing for an experiment with the new trivalent uranium optical maser. Trivalent uranium maser, and divalent samarium maser emit coherent light waves with sharply defined frequency, and propagate intense, highly directional beam*

Electron Tubes

Developments in electron tubes continue to reflect the emphasis placed on missiles, space exploration, and defense. Major efforts were made in 1961 to improve the reliability and performance of the tubes and associated components.

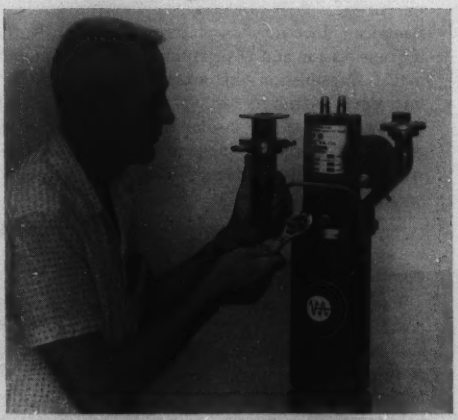
Super- or ultra-high power microwave tubes such as the Amplitron (an amplifier form of magnetron), traveling-wave tube amplifiers, and multibeam klystrons have been developed or are under consideration to increase the average power capabilities of the radar systems in which they are used. Increased average power is required as the range of the search radar systems is increased. In the past decade, the average power at microwave frequencies has increased from the kilowatt range to tens of kilowatts, with objectives of several hundred kilowatts. With peak power of outputs in the megawatt range, dissipation of losses in the tubes becomes of primary design concern.

Coincident with the need for higher power microwave tubes, has been the need and development of higher capacity hydrogen thyratron tubes. Such tubes operate as switches to impress the stored energy of the pulse forming networks on the microwave tubes of the radar system. Ceramic construction techniques have permitted the development of tubes capable of handling peak pulse powers of 48 mw and higher, at average powers of 50-100 kw.

In line with the efforts to provide more reliable tube performance, there is an increased tendency to "package" tubes, such as voltage-tunable magnetrons which operate in the kilomegacycle range with their essential system components (the magnet) as part of the manufacturing operation. This permits permanent adjustment of essential line-ups with the overall result that the user is assured of an optimum performance.

Numerous approaches are being investigated to provide electric power for satellites and space ships. Effort is directed toward development of lightweight efficient devices for the direct conversion of thermal energy into electric energy. Semiconductor solar cells using energy from the sun have proved very reliable. Thermal-electric and thermionic converters using the sun, nuclear reactors, or possibly isotopes as the prime source of heat, offer the possibility of higher conversion power densities. In the thermionic converter field, effort is being concentrated on the development of gas or vapor devices in which an ionized plasma minimizes the space charge drop. Output power densities of 2 watts per cm^2 at cathode temperatures of 1,300 C (anode 600-700 C) with efficiencies of 10 to 12 per cent have been attained in cesium vapor converters. Outputs of 4 watts per cm^2 appear feasible at higher cathode temperatures. Another interesting approach is to transmit power to a satellite on a microwave beam and convert the high-frequency energy to direct current. Magnetron tubes operating inversely as rectifiers are reported to have conversion efficiences of the order of 60 per cent. Other forms of electron tubes, such as klystrons and traveling-wave tubes are being considered as well as semiconductor devices.

In the industrial field a "tell-tale" gas (neon) is



Varian Associates' C-band traveling wave tube for operation at frequencies of 5.4 to 5.9 gc (gigacycles) (1 gc = 10^9 cps). Power gain 35 to 40 db over frequency range. Power output 4.5 mw peak, 5 to 6 kw average

being added to xenon inert-gas-filled thyratrons to provide an indication of low gas density or low cathode emission by a change in the color of the glow. At low xenon gas densities, or low emission, the tube arc-drop voltage rises and the color of the glow changes from the blue-purple of xenon to the orange-red of neon.

A new tool has been developed for gas analysis at the very low pressures attained in vacuum-tube work. The tube is a small mass-spectrometer that can be attached directly to a vacuum tube under investigation, processed with the tube, and used to identify the gases evolved during processing, or in subsequent testing after seal-off.

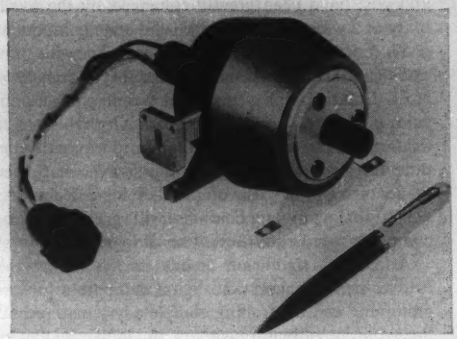
Most interesting in the research field is the laser or optical maser. See article by A. L. Schawlow on optical masers in the *Scientific American,* June 1961, p. 52-61. A laser (light amplification by stimulated emission of radiation) is similar to the microwave maser but operates in the visible and infrared region of the electromagnetic spectrum. Two forms, gas and semiconductor (ruby) lasers have been reported. In the gas laser, atoms of helium and neon are ionized by r-f "pumping" to a high density of excitation. Emission of a photon, by atomic capture of an electron returning to the ground state, triggers or stimulates photon emission throughout the length of the discharge with the result that an intense, coherent, narrow-frequency band of light is emitted. The coherence and bandwidth of the light output offers the possibility of a large extension in the number of communication channels where line-of-sight or reflected beams can be used.

Tung-Sol Electric has two additional hydrogen-filled diodes to add to its existing line of high-voltage devices announced earlier this year. This will extend the line from unit current ranges of 0.4 to 4.0 amperes average and from 16- to 25-kv peak inverse voltage. Although intended primarily for rectifier service, these hydrogen-filled tubes have also been designed in radar modulators as clippers and charging diodes.

In several high-voltage systems, the hydrogen-filled tubes were evaluated in direct comparison with silicon rectifier stacks. In addition to a price ratio of 1 to 6 for the tubes to the silicon devices, the hydrogen tubes withstood both current and voltage surges that destroyed the stacks.

The lower impedance of the gas-filled tubes provides more efficient rectification than that provided by vacuum-tube rectifiers. Type *7792* has been used as a direct plug-in replacement for vacuum types *X80* or *6303,* with a considerable reduction of heat in the rectifier compartment. Similarly, types *7789* and *7790* have been used as direct plug-in replacements for vacuum type *576A*.

Compared to mercury vapor tubes, hydrogen-filled tubes are virtually temperature free. The usual blowers or heaters used with the mercury tubes are not needed for hydrogen rectifiers, although at some ratings cooling air is recommended.



View of Sylvania's new backward-wave oscillator, type BW-4289, *for operation in the 18- to 26.5-gc frequency range. Designed as voltage-tunable signal source in microwave receiver local oscillator applications, test equipment, and signal-generating equipment, the* BW-4289 *has minimum power output of 5 milliwatts*

While gas-filled tubes (particularly xenon tubes) have been used commercially for some years, they have been limited to peak inverse voltages of 10 kv. Above this voltage the back bombardment of the cathode with the heavy gas ions kills the emitting surface. Lightweight hydrogen ions have little effect on the cathode surface. However, hydrogen is a very active element and it normally would be difficult to maintain a constant (low) pressure hydrogen atmosphere in a tube. The solution was to use a hydrogen reservoir such as is used in hydrogen thyratrons. The reservoir, a heated cylinder of titanium metal that has absorbed hydrogen, maintains a fixed gas pressure dependent on its temperature. Thus the tube can contain many, many times the envelope volume of gas, and still maintain a constant gas pressure during life. Because of continued improvement in reservoir design, the reservoirs need not be individually adjusted and are connected internally directly across the cathode heater.

Electronics and Electronic Circuits and Systems

The most significant achievements during the past year in the general field of electronic technology are the following:

Digital Computers

The digital computer area has probably experienced more significant developments than any other through a multiplicity of improvements in components and approaches. The practical advent of the magnetic thin-film memory, and rapidly developing other thin-film and integrated semiconductor techniques, make possible remarkably reduced size, weight, and power consumption, as well as increased reliability. In applications for digital computers, practical operating speed, efficiency and reliability

and cost have been greatly enhanced by the availability of a wide variety of new solid-state components, produced by continually improving fabrication processes (mesa, silicon-planar, epitaxial-type transistors, etc.). Further improvements in power consumption, gain, noise, etc., are expected through the use of the field-effect transistors now coming into quantity production. New approaches to digital logic have been made through the use of parallel logic techniques, which for many applications will greatly increase computer speed over present serial logic.

Additional significant trends are: (1) the ever heavier dependence upon digital computers for programming and controlling complex systems; and (2) the evolution of high-sensitivity and high-gain electro-optical techniques and components to perform digital logic, memory, and pattern recognition. Storage in military checkout and command control displays is also now possible.

Electric Power Conversion and Generation

In this area, the ready availability of the silicon-controlled rectifier has contributed greatly to the practicality of solid-state inverters, converters and power supplies, which have considerable advantages over contemporary rotary machine devices. A second significant event is the improvement in thermoelectric power generation techniques, to the extent that these elements, when combined with small nuclear heat sources, provide reliable, long-term electric power supplies. An example of this is the Martin nuclear power supply used in the recently launched Transit *4-A* satellite.

Microwave Technology

The important activities in this area have been: (1) the development by various agencies (University of Illinois, Collins Radio, Stanford Research Institute) of frequency-independent antennas such as the logarithmic-periodic generic type; and (2) the successful development of nanosecond solid-state r-f switches.

Guidance and Control

In the guidance area, gyro performance and reliability have been enhanced through such developments as the Sperry liquid center gyro and the Minneapolis-Honeywell ceramic gas-bearing-supported rotor gyro. A milestone in low-cost inertial guidance is achieved by Lear with their low-cost inertial platform. In control theory, the most significant activity is the development of optimal, nonlinear, and adaptive control theory by Kalman and LaSalle of The Martin Company.

Electromagnetic Propagation

The significant events in this field are the discoveries of hitherto unsuspected propagation paths, both atmospheric and underground, in various geographical locations for very-low, very-high and ultra-high frequencies; and the extension of normal propagation ranges through ion clouds and other techniques.

Space Communications

In this area, the important events have been the emergence of parametric amplifiers, lasers and masers from the laboratory stage to the production stage through the efforts of the Massachusetts Institute of Technology, Bell Telephone Laboratories, Hughes, and others, thereby extending the range of space communication, tracking, etc.

Nucleonics

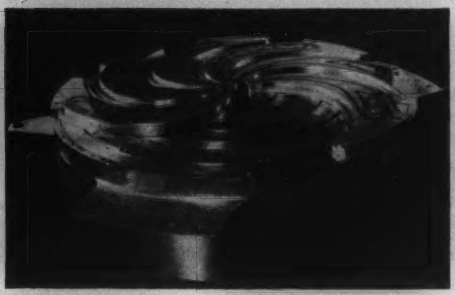
Engineers working in the field of nucleonics during the past year have witnessed a number of developments which will grow and multiply in coming years. Of major interest to the nuclear industry has been the emphasis on areas concerning nuclear application to space travel. Nuclear concepts for the generation of electric power in space through the use of small high-temperature reactors and direct conversion of heat or radiation from isotopes into electric energy are being intensively explored. Nuclear propulsion for long-range space travel is also being rapidly developed.

The successful operation of Dresden and Yankee plants has encouraged the industry to continue development of large power reactors. On the debit side, the *SL-1* reactor accident in Idaho Falls, Idaho, on January 3, 1961, taking three lives, emphasizes the serious hazards involved in reactor operation. While the explosion's specific cause may never be known, a detailed study by the Official Board of Investigation provided a profound lesson in reactor safety.

Also of great significance is the Supreme Court decision of June 12, 1961, verifying the legality of the AEC's procedure in the case of the Enrico Fermi Reactor now under construction at Lagoona Beach, Mich., by the Detroit Edison Company. The decision's major effects are (1) that designers may use the construction period to complete detailed verification of the safety aspects of the reactor; and (2) that reactors may be located near a metropolis without "compelling reason."

One of the most successful nuclear programs is the rapidly growing nuclear U.S. Navy. As of September 1961, our Navy includes 20 operating nuclear submarines, 6 launched and being fitted out, 14 keels laid (under construction), 17 assigned to shipyards for early construction, and 3 authorized. In addition, one cruiser is being launched and fitted out while an additional one is authorized for early construction, a total of 65 nuclear-powered naval vessels.

The year 1961 has also seen several notable accomplishments in the field of high-energy plasmas and particles. The successful operation of the 50 mev (megelectron volt) proton fixed-frequency cyclotron at the University of California at Los Angeles, Calif., has greatly encouraged the development of a new generation of fixed-frequency medium-energy cyclotrons. The successful acceleration of electrons in the Oak Ridge National Laboratory (ORNL)



To permit precision magnetic field calculation, magnet pole structure of ORNL's cyclotron analog is entirely free of iron. Main field coils recessed in aluminum support casting overlaid by set of eight sector coils, providing azimuthal field variations for focusing. Copper sector coils imbedded in anodized aluminum plates for cooling and rigid mounting

cyclotron analog has also been encouraging. Since its completion and initial operation in 1960, the performance of the world's highest-energy accelerator, the Brookhaven alternating gradient synchrotron, has been steadily improved; energies up to 33 bev are achieved with a beam intensity exceeding 3×10^{11} protons per pulse. One of the most dramatic developments in 1961 is the discovery of high-field superconductors. At liquid helium temperatures, thin strands of Nb_3Sn can carry 2×10^4 am/cm^2 in magnetic fields up to 100 kilogauss without resistive power dissipation; NbZr can carry 10^5 am/cm^2 up to 50 kilogauss. These properties will most likely find their earliest use in magnets for instrumentation of high-energy accelerators and in other physics experiments using high fields.

Semiconductor Rectifiers

The year 1961 saw the introduction of double-diffused, all-hard solder construction of silicon-rectifier diodes giving high-current high-voltage thermal fatigue-free operation. These are available for circuits requiring 100 or more amperes per diode and transient peak-reverse-voltage ratings up to 1,300 volts.

Widely recognized as an industrial practicability during 1960, the silicon-controlled rectifier (SCR) has gained increasing recognition in 1961. The rating are increased to approximately 100 amp per SCR, making available its application in equipment designed for adjustable voltage output, such as d-c motor drives. Besides the wide use in industrial and military applications, the SCR has made several inroads into the consumer markets. This year saw the first volume production of semiconductor-controlled rectifiers for residential applications—especially in home lamp dimming circuits. There was also the introduction of a simple low-cost speed-control circuit using a single SCR and a universal motor. This has made possible many performance improvements in such applications as powered hand tools, appliances, and process machinery.

Introduction of a SCR switch, which is triggered by light instead of current, also occurred during 1961. This device is ideal for electrically isolated control of power by semiconductor devices, and can also be used with static switches, alarm systems, position controls, and limit switches.

A new selenium transient voltage suppressor was developed and became commercially available. This suppressor is a specially manufactured selenium rectifier cell having its reverse characteristics altered to provide a very sharp I vs. E trace. Because of the defined knee and steep slope of the curve, the rectifier cell performs in a manner similar to a zener diode. This characteristic makes the device a very effective transient voltage suppressor, to be connected across the a-c input of silicon and germanium rectifier devices, and SCRs. This particular selenium device has characteristics suitable for limiting voltage transients to safe, predictable values.

Solid-State Devices

In the past year there have been major developments in two new areas of solid-state devices: thermoelectric devices and microsystems. In thermoelectrics rapid progress took place in cooling and power generation. In cooling, several consumer products including a water cooler and an ice cube maker have been introduced. Multistage coolers for infrared detectors were developed. In power generation, units for cathodic protection of pipe lines are being field-tested by several companies. Generators were constructed with the use of nuclear isotope, solar radiation, and chemical prime-energy sources. The larger generators are in the range of several kilowatts.

In microsystems, there have been major advances in all fields, from microminiaturization to molecular electronics. Within the micromodule concept (the approach of employing miniaturized special active and passive components on flat insulating substrates) a number of equipments were successfully demonstrated. Several active components have reached the manufacturing stage. The thin-film approach to microsystems involves the construction of subsystems upon insulating substrates using deposited insulating and resistive films and active devices with special encapsulations consistent with the wafer structure. The field has been actively advanced by a number of manufacturers. Rather complex thin-film systems have been demonstrated at the laboratory stage of development. In the field of integrated circuits and molecular electronics, several basic computer subsystems have been introduced to the electronics industry. These perform the required system function within monolithic semiconductor elements without use of separate active and passive components. Electronic systems employing such monolithic structures or functional blocks are under development.

J. G. NOEST and G. S. STORMS

Control system design for generating stations

D-C control system design for generating stations built on the "unit" principle is discussed from the standpoint of segregation, reliability, and continuity. Localization of the d-c control circuit and an interposing 48-volt direct-wire supervisory system minimizes failure while retaining local control for emergency operation because of loss of control panels, circuits, or other central control room equipment

From the Fall of 1951 to the middle of 1961, Consolidated Edison has added seven turbine–generators, which total 1,870 mw, to its system. There are presently in various stages of construction, four more units totaling 1,230 mw of additional capacity, with service dates to the Fall of 1963. Each of these units is, or will be, designed on the "unit" principle, that is, each unit is, or will be, completely independent of its neighbor in any of the generating stations in which it is located.

With Consolidated Edison, it is a fundamental requirement that units in stations built on the unit principle be completely independent of other units in the same station to the maximum degree that this is reasonable. This means that the failure of one unit cannot affect another unit in operation at the same station.

With adherence to the unit principle, a generating unit consists of a boiler assembly with its own fuel supply, feed-water supply, etc., a turbine with its own auxiliaries; and one or two generators with their own auxiliaries and excitation systems.

In spite of the fact that in all recent installations two main units are controlled from one control room with the control power supply common for the two units, it is so designed that it fully complies with the unit principle.

These basic considerations are applied in the design of the control system: All operating or protective functions must be either fail-safe or continually monitored by a fail-safe monitoring system; the circuitry associated with operating and protective functions must be designed to afford a minimum of exposure to damage from other equipment failure, particularly from failures on equipment associated with adjacent units; the portion of the control system associated with one of the pair of main units, controlled from one control room, must be effectively independent of that portion associated with the other. ("Fail-safe" for the purpose at hand is defined as an operation by which the unit is safely shut down on failure of a circuit or device.)

Essentially full text of paper 61-1032, recommended by the AIEE Power Generation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Detroit, Mich., Oct. 15-20, 1961. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1961.

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CONTROL POWER SUPPLY

With the availability of stored-energy, pneumatic, or motor-driven operating mechanisms for circuit breakers, it has been possible to reduce the capacity requirements of the control power-supply equipment to a marked degree. A 125-volt control power system is adequate for a unit which ties to the system directly, that is, without a bus load at generated voltage. Where the control power supply is not used to supply an emergency oil pump for the turbine–generator, the design is based on the need for an 8-hour supply without an external power supply to the plant.

Typically then, a control power-supply system is as shown in Fig. 1. It consists of two independent 125-volt busses, each having a 3-kw motor–generator or rectifier and each having a 200-ampere-hour 58-cell lead storage battery. A third motor–generator or rectifier has been provided in most cases as a spare with connecting facilities to each of the two busses through interlocked circuit breakers, which prevent the tying of the two busses. Each motor–generator or rectifier has automatic voltage control which maintains the voltage to the proper value for floating the battery. The load is normally carried by the motor–generator or rectifier. Manual voltage control is provided and used for battery charging.

To assure segregation of the components of the control power supply, the motor–generator sets or rectifiers are physically separated. Their supply is from the separate auxiliary supplies for the two units. The batteries are in separate masonry compartments. The load boards and distribution panels are in separate steel enclosures with physical separation between them.

From the two busses a pair of control feeders, one from each bus, with manually operated circuit

breakers run to the various locations where control power is required. Each of the pair of feeders is physically separated from the other of the pair, either by locating them in different cable trays or by separate conduits. The feeder-circuit breakers are provided with instantaneous and thermal trips. The tripping of any of these breakers is indicated by the operation of an alarm through a slip contact on the breaker, which is closed when the breaker is closed and opens only when the breaker is tripped from its trip device.

The individual feeders of a pair first come together at the automatic throw-over switch on which they terminate. This throw-over switch throws over to the alternate supply, which is the other feeder of a pair, on failure of power supply from the first feeder. To return to normal requires manual resetting. The operation of any throw-over switch is alarmed and announced.

In this way the complete loss of one of the load boards leaves both units operable with full protection and all controls supplied from the other load board.

In order to reduce the exposure of control-system circuits to a minimum, the 125-volt control is kept localized as much as possible. This is done by the provision of a 48-volt d-c direct-wire supervisory system which, through operation of interposing relays at the controlled location, performs the operating functions. Through other interposing relays, the system provides signal light indication at the controlling point which, in most cases, is the central control room; see Fig. 2.

The 48-volt control power supply is similar to the 125-volt system in that two separate busses are provided, each with a voltage-regulating rectifier-type battery charger large enough to carry a normal load, float a battery of 23 cells, and have a capacity sufficient for 8 hours' operation without a-c power.

The spare 125-volt motor–generator or rectifier is provided with a resistor so that it can be used to charge a 48-volt battery in case of a rectifier failure.

In the 48-volt control power system, there are pairs of feeders, each pair of which terminates in manual throw-over switches over a different route. These, in turn, supply distribution panels, which supply local circuits through fused switches. The principal differences between the 125- and 48-volt circuits are: (1) the 48-volt circuits are not as numerous nor as widely subdivided; and (2) the 48-volt control system serves two units that are operated from one common control room. This may seem to violate the unit principle but actually does not, since the complete failure of the 48-volt system does not cause loss of generating capacity as local controls permit continued operation, although in a less convenient manner and with increased manpower requirement.

In one instance, where a fire completely burned out the central control room switchboard, it was possible to resume operation of the affected unit in 48 hours by operation via the local controls.

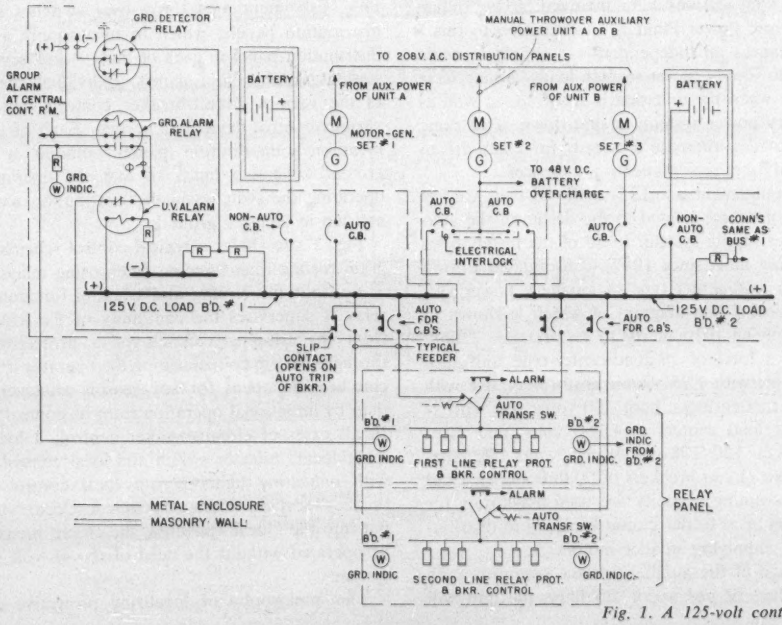

Fig. 1. A 125-volt control system

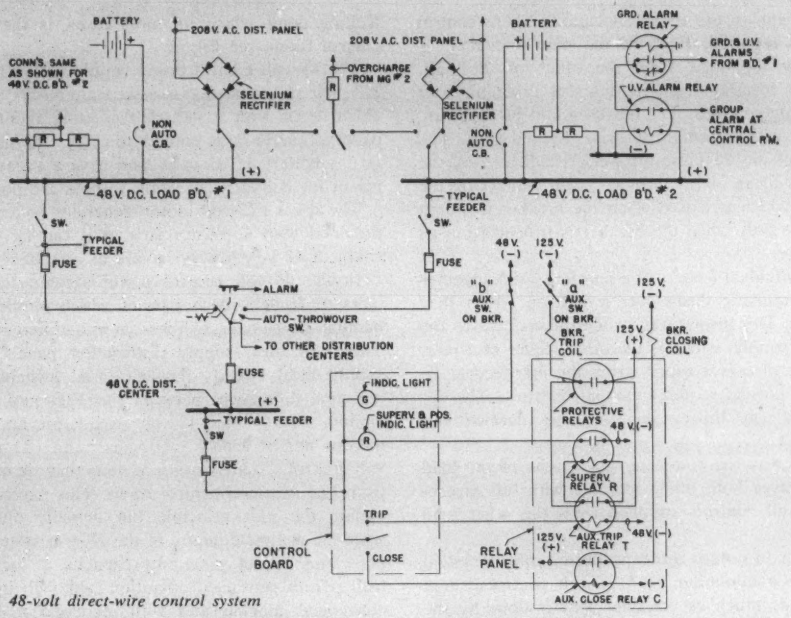

Fig. 2. A 48-volt direct-wire control system

The 125-volt and 48-volt d-c control power supplies are ungrounded and ground supervision is provided as shown in Figs. 1 and 2.

Up to the present time it has not been found necessary to provide an a-c control system in any of the generating stations here involved. (The Indian Point Atomic Power Plant is an exception to this.) In all instances an independent a-c supply is made available to supply power to such loads as may have to operate when the unit that is involved, as well as its auxiliary power system, is shut down. This same supply provides alternate a-c feeds for clock-driven motors and other miscellaneous a-c devices.

The arrangement of 125- and 48-volt control feeders is of course related to the design of the auxiliary power supply system. In all of the installations of generating units since 1947, Consolidated Edison has used a load-center type of auxiliary power system, a typical 1-line diagram of which is shown in Fig. 3, applying particularly to Astoria no. 3 unit. There are a total of 19 load-center-type unit substations: nine with 1,250-kva transformers, five with 2,500-kva transformers, both 480 volts; one with 2-transformer load centers at 4,160 volts; and three with 937-kva 120/208-volt transformers. Remote-controlled air circuit breakers of 50,000 amperes and higher interrupting capacity are used as starters for large motors or as feeder-circuit breakers to distribution panels supplying smaller motors.

The design of the auxiliary power system is such that on failure of one major auxiliary, the unit will generally trip out but can then be restarted and operated on one set of auxiliaries at reduced load.

In conformance with this, the 125-volt control feeders are so arranged that five pairs for each unit (in the case of Astoria no. 3 and no. 4) feed through previously mentioned throw-over switches and five distribution panels, which in turn supply a further distribution panel in each of the 19 load-center substations. From these panels, individual feeds lead to the various circuit-breaker controls and to the various control devices as needed. Each of the last-mentioned distribution panels contains a set of ground indicating lights so that the operators, by operating the switches in the distribution panel, are assisted in locating grounds.

Fig. 2 also shows a typical control schematic diagram for a circuit breaker. Interposing relays *C* and *T* transmit the closing and tripping function, while relay *R* supervises the continuity of the trip circuit from the tripping contacts of a protective relay through the trip coil, alarming the operator if the circuit breaker opens for any reason whatever, other than by intentional operation from its control switch. In all cases of circuit-breaker control, a local "remote–local" selector switch and local control switch with indicating lights permit local control at the breaker location. When this control selector switch is put into the "local" position, the circuit breaker can be operated without the need of the 48-volt control system.

This philosophy of localizing protective circuits

is carried through to current-transformer secondary circuits. Thus, whenever a current transformer is used for protection as well as remote metering, the metering is isolated from the protection by an auxiliary current transformer, generally with a 5-to-1 ratio, and with characteristics such that an open circuit in the secondary circuit of the auxiliary current transformer will not increase the burden on the main current transformer to a degree where the protective accuracy is materially affected. On potential-transformer secondary circuits, the ability to fuse selectively avoids the necessity to use auxiliary potential transformers.

MONITORING, ANNUNCIATING, ALARMS

In all of the new installations here involved, there is provided a system for the protection of turbine–generators and boilers which causes the unit so protected to trip off and safely shut down from mechanical and electrical protective devices. This protection system requires a considerable number of devices, such as pressure switches, flow switches, temperature-actuated contacts, and interlocking devices, all of which must either be fail-safe or monitored by a fail-safe circuit.[1]

Since many of the functions, which in this system eventually cause trippings, change rather slowly, it is possible to give advance alarms to alert the operator to the developing situation, often in time for him to accomplish corrective actions. This is done by means of an advance alarm annunciator.

When tripping occurs, it is imperative that the operator be able to learn quickly just which device has initiated the tripout since, in the process of shutting down, several other devices may attempt to trip and thus incorrectly claim initiation of the tripout. To avoid such confusion a trip annunciator has been designed, which announces the initial device that caused the tripout and thereafter locks out all other indications.

Fig. 4 shows the connection diagram of this scheme and Fig. 5 the connection diagram for the advance alarms and the miscellaneous alarms. It should be noted that the advance and miscellaneous alarms operate from circuit-opening contacts while the trip alarms operate from monitored circuit-closing contacts. By having circuit-opening contacts in the advance alarm and miscellaneous alarm-initiating devices, the annunciators become fail-safe circuitwise. Considerable effort is also made to have the initiating devices fail-safe inasmuch as an actuating force is required to hold the device in the normal position. When this is not possible, as is sometimes the case, redundancy is used.

Such redundancy exists automatically in the case of the advance alarm annunciator since the next step by which the monitored variable tends toward unsafe conditions causes tripping. For instance: "low"

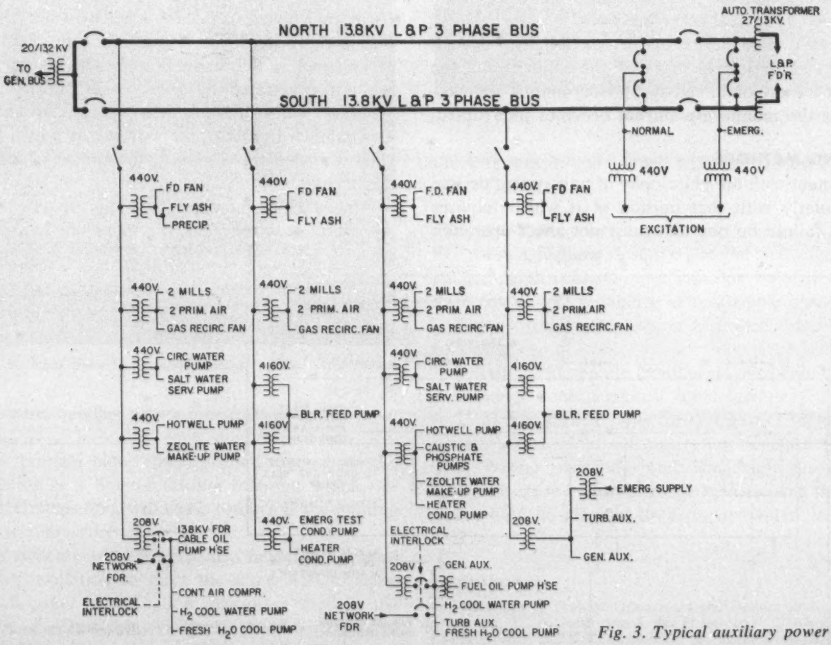

Fig. 3. Typical auxiliary power supply

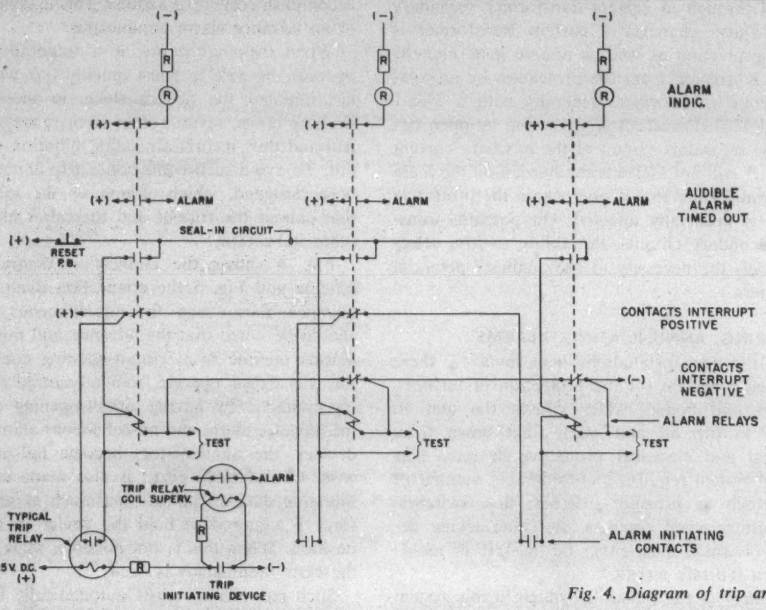

Fig. 4. Diagram of trip annunciator

turbine oil reservoir level actuates an alarm by the float switch opening its contacts. "Low-low" oil level from a separate device causes tripping of the unit. A similar arrangement is used on the boiler drum water level and in several other instances.

In the case of the trip alarms, the initiating devices are circuit closing. In that case the continuity of the circuit is monitored, and supervisory alarms are actuated if the monitoring current becomes interrupted.

WIRING METHODS

Consistent with the philosophy of unit system design, particularly with that portion of it which requires that a failure on one unit must not affect operation of another, a great deal of thought has been given to the design features relating to control of damage resulting from a switchboard fire.

To begin with, all panels in the central control room are isolated from each other by a steel dividing wall and by steel rear doors, which in effect make every panel a cubicle; see Fig. 6. The dividing walls are not penetrated by wire or instrument piping. Wherever wires or instrument piping is brought into a switchboard cubicle, the entrance is sealed with a glass wool batten to prevent the spread of a fire by this means.

Almost all of the control circuits which run from the central control room to equipment in the plant

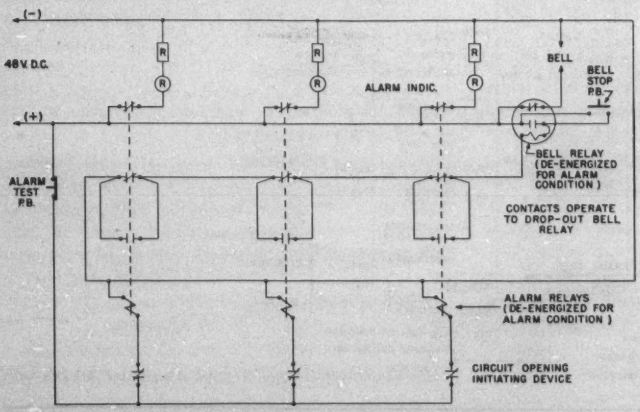

Fig. 5. Advance alarm and miscellaneous alarm system

are in multiconductor control cables. Where such cable on its run in the plant is exposed to steam or water leaks, the cable is in lead sheaths. For all other runs the multiconductor cable is covered with heavy mineral-filled asbestos braid.

The individual control wires which make up the cable are flame resistant, that is, they will successfully withstand the *ASTM-D-470-59T* vertical flame test.

Between the central control room and equipment in the plant, the control cables are run in covered metal trough which is provided with fire stops in the form of glass wool battens at frequent intervals as well as at every tee point.

At their termination in the control room, where the multiconductor cable must be separated into individual wires, flame-resistant glass cloth tubing is used on the individual wires and, in addition, exposed wire bundles are wrapped in asbestos tape; see Fig. 7.

Fig. 6. Rear doors of central control room switchboards

The terminal block material used throughout the installation is a flame-retarding material which, although combustible, will cease to burn if the igniting flame is removed.

The switchboard wiring is also made with flame-resisting insulation to meet the same ASTM flame test. All paper identification tags often used in the process of identifying wires are carefully removed before the equipment goes into service. Permanent wire identification is made by means of flame-resistant marker strips at the terminal blocks.

The smallest wire size for switchboard wiring is no. 16 AWG. All control wires except current-transformer secondary wires, thermocouple wires, and similar low-energy instrument wires are fused or protected by circuit breakers that are co-ordinated with the wire size in accordance with the National Electrical Code.

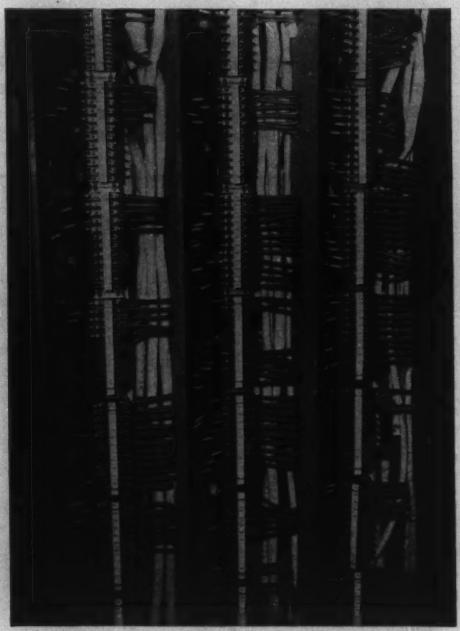

Fig. 7. Control room terminal board wiring

CONCLUSION

The design features described in the preceding discussion have evolved from concepts related to the need for utmost reliability at reasonable cost.

The control system design described features the following:

1. Ability to operate from local controls in case of a failure of central control room facilities
2. Maximum reliability for that part of the control system upon which fault protection depends
3. Wiring methods and enclosure provisions which insure minimum damage by localizing the area that would be affected by a fire or water or steam leak.

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D. J. HARRIS

Direct generation of electric power from a high-velocity gas jet

The possibility of generating electric power by the electromagnetic braking of a high-velocity gas jet is discussed. Outstanding problems are assessed and suggestions are put forward for the solution of some of them, but the need for more research is emphasized

The continued economic expansion of our society depends upon the growing availability of distributable power, and most of the burden of this increase will fall upon the electric power generating industry. The output of electrical generating plant doubles about every 10 years, but the demand is still greater than the supply. In spite of the vast amount of electric energy (about 10^{12} kw-hr) produced every year, the efficiency of modern fossil fuel power stations is only about 35 per cent. Any method for increasing this efficiency would be of great importance. The major loss of energy in the conventional process occurs during the conversion of thermal energy in the working fluid to mechanical energy at the electric generator; i.e., in the turbine part of the system. This conversion efficiency could be increased by raising operating temperatures, but there is a practical limit in machines operating with high mechanical stresses.

The concept of omitting the turbine element and converting the working fluid itself into an electric conductor which can interact directly with a magnetic field to produce electric energy is not new. Experimental work following up the early suggestions has not been reported, but interest has been recently revived in such a generation process.[1-4] These later proposals envisage the production of high-velocity gas jets which are partially ionized and therefore electrically conducting, braking of the gas being effected by a transverse magnetic field. A schematic diagram of the generator is shown in Fig. 1. The reverse of the process is also of present interest as a means of rocket propulsion.

It is necessary to consider both the thermodynamic problem of producing a high-velocity high-temperature jet of gas or vapor and the electrical problem of making the jet electrically conducting and then transferring its energy to an electric circuit.

THERMODYNAMIC PROBLEMS

A great deal of experience has been amassed on the production of high-velocity jets, and techniques for producing them are available. The procedure is to compress the gas, raise it to a high temperature, and then expand it adiabatically through a convergent–divergent nozzle to a relatively low pressure. A high gas temperature, as well as a large directed velocity, is required if thermal ionization is to be used to increase the electrical conductivity of the gas. A jet velocity of 1,000 meters per second, a gas temperature of 2,000 C, and a gas pressure of 1/10 atmosphere would be typical of possible emergent gas conditions obtainable with existing techniques.

An open or a closed cycle could be used in a generator. In the former, preheated and precompressed air is raised to a high temperature by the combustion of high-grade fuel in it. Fuel oil as in a normal jet engine, or pulverized coal, has been suggested. The emergent jet of gas from the nozzle then includes the products of combustion. This system has the advantage of simplicity, but the presence of combustion products with a strong affinity for electrons would tend to cause quick reduction of the electrical conductivity of the gas. The closed cycle allows the free choice of a working gas other than air. The gas is compressed, raised to a high temperature in a furnace, and then expanded through the nozzle. After energy is extracted from the jet, the gas is fed back to the beginning of the cycle. Since combustion does not take place in the gas itself the problem of heat transfer to the gas is introduced and the closed cycle is likely to operate at a lower temperature than the open cycle. Being able to choose an operating gas of low ionization potential, if required, could well compensate for any additional problems involved. The closed-cycle system has been suggested for a generator associated with future high-temperature nuclear reactors.

Essentially full text of paper CP61-1091, presented at the AIEE Fall General Meeting, Detroit, Mich., Oct. 15-20, 1961, at a session sponsored by the AIEE Power Generation Committee.

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The author is grateful to Profs. M. W. Thring and A. L. Cullen of the University of Sheffield for their stimulating interest and helpful contributions in this work.

Another choice lies between continuous and pulsed operation of the jet. Pulsed operation has advantages in allowing higher operating temperatures during the pulse and a higher thermal efficiency. Advantages from the electrical point of view are discussed later. Pulsating combustion chambers have received considerable development (they were used in the V-1 flying bomb), and tubeless resonator combustion chambers,[5] or "organ-pipe jet engines," could allow operation at frequencies of hundreds of explosions per second. They could well be applied in this generation process.

Although further development is required on methods and materials that will afford higher gas temperatures in the jet, and higher operating frequencies in the case of the pulsating jet, no fundamentally new approach is required and the problem is largely one of improving present techniques.

TRANSFER OF ENERGY TO AN ELECTRIC CIRCUIT

The electrical process requires the introduction of electrically charged particles into the otherwise neutral gas stream with a subsequent change of characteristic of the gas from an insulator to a poor but significant conductor of electricity. Energy has then to be transferred from the stream to an electric circuit by interaction between the charged particles and the circuit.

The basic processes can be conveniently considered in three distinct groups: the change of electrical characteristic of the gas to that of a conductor, methods for transferring the kinetic energy of the charged particles to an electric circuit, and the transfer of energy from the neutral particles to the charged particles. It is the charged particles only that can interact with electric or magnetic fields, and if there were no energy-transfer process, the efficiency could not be greater than the percentage ionization in the gas stream. Each of these sections will be considered in turn.

Production of Charged Particles

Methods available for the ionization of some of the gas molecules in the jet stream include:

1. Injection of a beam of energetic charged particles; e.g., electrons, with subsequent ionizing collisions.

2. The application of very high electric fields with resultant initiation of gas discharges. This might be done using high-frequency alternating fields when no electrodes are required in the gas, or by a high direct voltage on thin wires, in the gas stream.

3. Thermal ionization in which the high temperature of the emergent gases is the ionizing agent. The ionization potentials of normal jet gases are too high for them to be appreciably ionized at the gas temperature. It has been suggested that low ionization potential substances (e.g., sodium, potassium, or cesium) might be injected into the jet.

Ionization schemes 1 and 2 require the feedback of power from the output of the generator. Even if all the kinetic energy of the jet were used for this purpose only about 3 per cent of the molecules in an air jet would be ionized. Thus, the degree of ionization realizable is limited to a fraction of a per cent. There would be great problems of beam production and dissipation in the electron beam method, but both schemes would facilitate periodic pulsing of the ionization of the jet, which would be convenient for induction generation methods.

The electrical conductivity of high-temperature air, which contains a small percentage of low ionization potential material, can be calculated with the use of the Saha equation and known values of mobility. The ionic current contribution may be neglected. Conductivity values for air containing 1 per cent partial pressure of sodium or potassium are shown as a function of temperature in Fig. 2. This conductivity is not sensitive to pressure over the range of practical interest. Thermal equilibrium is assumed, and loss of electrons due to diffusion or capture is neglected. Compared with copper, the gas is a poor conductor even at the highest temperature conceivable. However, any practical scheme will have to make use of a conductivity of this order.

After the introduction of charged particles into the gas stream, the problem is to transfer their energy to an electric circuit.

Extraction of Energy from Charged Particles

Charged particles will interact with electric and magnetic fields and either could be used to extract energy from the particles. Electric field methods present problems, as the jet will usually contain positive and negative charges in equal numbers. Generators using electric fields would require some charge separator to remove charged particles of one polarity before the gases enter the electric field interaction region. Attention has therefore been focused mainly on magnetic methods of generation. Schemes suggested include charge separation methods, where a transverse magnetic field is used to separate the electrons and positive ions of the ionized gas with the subsequent production of an electric field, and induction methods, where currents are induced in a coil by motion of the particles under the action of an alternating magnetic field.

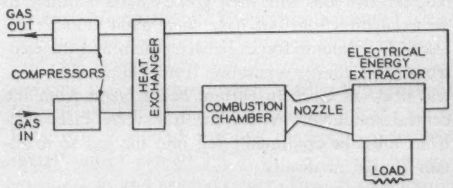

Fig. 1. Schematic diagram of open-cycle generator

Of the charge separation schemes, the most straightforward is the one in which a magnetic field is imposed perpendicular to the direction of motion of the conducting gas as in Fig. 3. An electric field is produced in a direction perpendicular to both the magnetic field and the velocity of the gas, and has a magnitude of about 1,000 volts per meter per weber per square meter for a typical jet. Braking of the particles results from the interaction of the gas current and the transverse magnetic field. To maintain

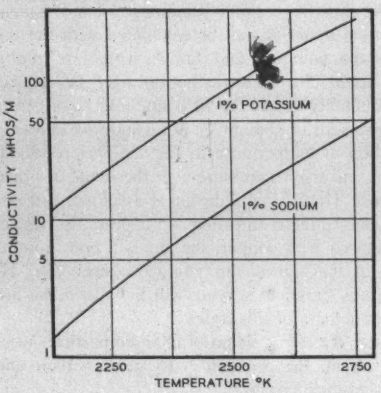

Fig. 2. Electrical conductivity of air with alkali metal added

charge neutrality in the gas and current continuity in the output circuit, electrons must be injected continuously to replace those removed to the collecting electrode. These electrons could be provided by thermionic emission, although very large emission currents (e.g., 1,000 amperes per megawatt output) would be required. A similar scheme using radial geometry could be used, in which a radial magnetic field gives charged particles a circumferential velocity and greatly reduces the axial velocity of the electrons. The positive ions with their greater mass continue in an axial direction, but have their axial velocity reduced by coulomb forces between them and the electrons. This charge separation results in an axial electric field, an electron current being taken from the central conductor. As for the transverse case, electrons must be continually fed into the gas to maintain charge neutrality.

Induction methods are generally to be preferred to those requiring electron removal and injection. These methods produce alternating rather than direct currents. Fig. 4 shows one suggested scheme. An alternating radial magnetic field produces a circumferential electron current as before, alternating in direction. This current, acting as a primary transformer current, is coupled into a secondary winding, which is the output of the device.

The effective change of inductance to alternating current of a cylindrical coil when filled with a conductor might be used to extract energy from a pulsed jet of ionized particles. The need for a pulsed jet and alternating current lies in the fact that for a reasonable change of inductance the magnetic flux distribution must be changed. This condition is satisfied if the skin depth in the conductor at the alternating frequency is not too large compared with the coil dimensions. No iron circuit is required for this device.

The effective change of inductance can be calculated, and the fractional change for a cylindrical coil of radius 1 meter and conducting core of radius ½ meter is plotted as a function of core conductivity for several different frequencies in Fig. 5. It can be seen that for a change of inductance of 1 per cent or more, and a conductivity that might be obtainable (e.g. 100 mhos per meter for 1 per cent potassium and 2,500 degrees Kelvin), a frequency of about 500 cps is required. This could be achieved by pulsing either the jet or the ionization process.

A possible scheme for using the varying inductance is shown in Fig. 6. Resistance r is much less than the load resistor R, and the inductance L_∞ is considered very large. A direct current flows in the variable inductance through resistor r and inductance L_∞. If, now, the variable inductance is modulated by the ionized jet an alternating current is produced which will flow in the resistor R. Coupling is by interaction of circumferential gas currents produced by the radial component of the magnetic field at the ends of the coil, with the coil current. The frequency of the induced alternating current will be equal to the pulse frequency. A high efficiency results if $r \ll R$. An alternative scheme uses the parametric oscillator principle. If in an electrically resonant circuit consisting of capacitance and inductance

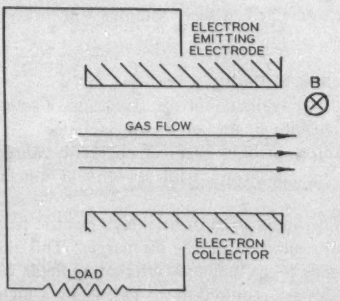

Fig. 3. Energy extractor using transverse d-c magnetic field

either element is varied periodically at a rate twice that of the electrical resonance frequency, then electrical oscillations will build up in the circuit. The inductance must be increased at a time when the circuit current is a maximum, thus increasing the energy stored in the inductance; i.e., energy is ob-

tained from the inductance-changing mechanism. The inductance is then returned to its normal value when the current is zero, and there is no energy transfer. This process is repeated each half cycle, energy being transferred to the electric current. If the product of jet pulse frequency and inductance change is greater than the circuit resistance, oscillations will build up. The advantages of this second scheme are that it is self-exciting and that no large direct-current source or high d-c magnetic fields are required. The main disadvantages are that the jet pulse repetition rate is stepped up by a factor of two and the resonant capacitors might be fairly formidable.

For either of these two schemes the device envisaged would consist of a high-melting-point insulating tube (e.g., silica or ceramic) through which the jet would pass, with little reduction of temperature. Interaction would be with an inductive coil with an inductance of a few henries on the outside of the tube. If insufficient energy is removed by a single coil, a series of coils could be used.

Transfer of Energy from Uncharged to Charged Particles

Interaction of particles with electric or magnetic fields can result in energy transfer from the charged particles only, whereas most (more than 99 per cent) of the kinetic energy in the jet is carried by uncharged particles. There must, therefore, be some mechanism for transfer of kinetic energy from the uncharged to the charged particles for a generator to be practical.

Three possibilities are:

1. A braking mechanism whereby a retarding force is exerted on the electrons, and energy is transferred from the gas molecules to the electrons by direct elastic collisions.

2. A braking mechanism whereby a retarding force is exerted on the positive ions, and energy is transferred from the gas molecules to the positive ions by direct elastic collisions.

3. A braking mechanism whereby a retarding force is exerted directly on the electrons, and subsequently on the positive ions by coulomb forces between electrons and positive ions, with the energy of the gas molecules transferred to the positive ions by elastic collisions.

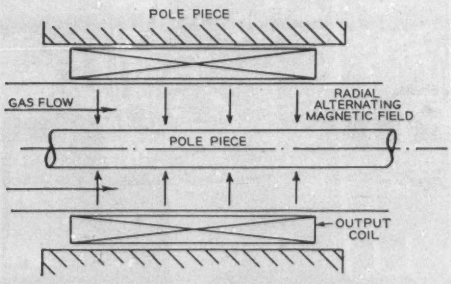

Fig. 4. Induction generator using radial magnetic field

Mechanism 1 is likely to be an ineffective method of energy transfer, even though the braking of the electrons by the transverse magnetic field will be very strong. This ineffectiveness results from the large difference in mass between the electron and gas molecule, with less than 0.01 per cent of the gas molecule energy transferred at each collision.

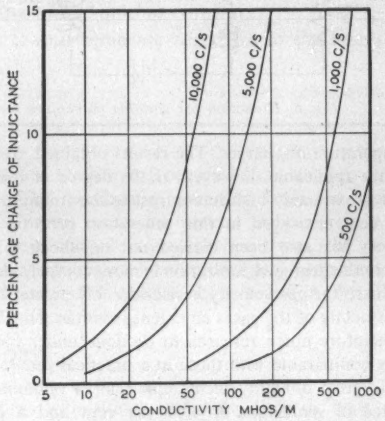

Fig. 5. Effective change of coil inductance

Mechanism 2 would not suffer from the disadvantage of mechanism 1, since the positive ions and gas molecules are of comparable mass but the relatively low mobility of the positive ions results in only a small transverse positive ion current and, hence, only a small braking force on the ions.

The third mechanism relies upon the positive ions as a transfer agent only, transferring the energy of the gas molecules to the electrons and hence to the external electric circuit. The picture envisaged is one in which the electrons are stopped by the magnetic field; the positive ions and gas molecules are swept through the electrons, when a retarding coulomb force is exerted on the positive ions; and the whole jet stream is slowed down as the result of a "frictional" effect caused by elastic collisions between positive ions and gas molecules. Thus, both electrons and positive ions play a vital role in the process.

THE FEASIBILITY OF A PRACTICAL GENERATOR

Techniques are presently available for producing suitable gas jets of high velocity and temperature. Developments leading to higher velocities and temperatures would be of even greater value. Pulsating combustion methods require the raising of the frequency of operation, and closed-cycle operation with

its many accompanying advantages will require the development of efficient heat exchangers for work at very high temperatures.

In recent years, much information has been obtained on the behavior of ionized gases moving in a magnetic field, especially in the realm of very high

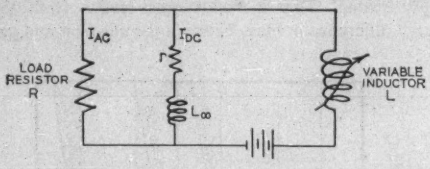

Fig. 6. Excitation for variable inductance method

temperature discharges. The results obtained are not highly applicable, however, as the degree of ionization is extremely high in contrast to the fraction of a per cent envisaged in this generation process. Research has also been carried out on shock waves where the degree of ionization is more comparable,[6-8] but here the gas velocity is considerably greater than the velocity of the gases emergent from the jet. There is therefore much research to be done under conditions comparable with those in a practical generator.

No great difficulty seems apparent in obtaining a degree of ionization of 0.01 per cent and a conductivity of 100 mhos per meter in the emergent gases. This could be produced thermally by introducing about 1 per cent of potassium into the jet at possible working temperatures (the potassium could be reclaimed), or by some external ionization method when a few per cent of the generated power would be required. It is also not difficult to visualize that the kinetic energy of the charged particles could be transferred to an electric circuit by interaction with electric or magnetic fields, even though technical difficulties might be encountered. Experimental generators have recently been reported[1-2] in which up to 10 kw of electric power was produced by passing an ionized gas jet through a transverse magnetic field. This shows that at least some of the kinetic energy carried by the charged particles can be transferred to an electric circuit.

It has also been shown that a large radial magnetic field is effective in slowing down ionized gas in a shock wave at velocities about ten times that of sound. Induction methods for energy transfer are much more attractive than those in which electrodes, one of which is electron-emitting, are placed in the gas stream. Induction methods, where cylindrical coils are wound axially with the jet, have the advantage that gas flow can take place in tubes of good thermal insulation with subsequent low reduction of temperature of the gas along its path. With this method, pulse jet operation will be necessary. For a generator of usable efficiency, it will be vital that an effective energy exchange process between the braked charged particles and the uncharged particles should exist. It is difficult to assess just how effective possible processes will be; however, further research is required. Work is needed both on the basic collision processes (collision cross section, type of scatter, etc.), under conditions of comparable drift and thermal velocities, and on the energy transfer methods as a whole to see how effective they really are in transferring energy from the gas molecules to the electric circuit.

Although much more information is required before the feasibility of a practical generator can be confidently assessed, the possible resulting advantages offer every inducement for further work in this field.

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Specially designed electronic data-processing equipment that forms the "nervous system" of the Air Force's Ballistic Missile Early Warning System (BMEWS) is shown undergoing tests at BMEWS site II, Clear, Alaska. This site became operational on July 1, about 9 months after site I at Thule, Greenland, began operation. Sylvania Electric Products Inc. is responsible for the design, manufacture, and installation of the data-processing equipment.

R. M. GARDNER

Analog computer simulates heart response to nerve stimulation

Because the heart is a dynamic system whose rate changes with stimuli and time, it lends itself well to study by means of the analog computer. Experiments have been made on both the steady-state and dynamic response of the heart to vagal and sympathetic nerve stimulation

The human heart is a very complex muscle-pump system which is controlled from several different areas of the body and by many factors. Because of the experimental difficulties and the complexity of the system itself, no complete mechanical or electrical model of the system has been constructed.

This article deals with but one set of control variables—vagal and sympathetic nerve stimulation. Heretofore the study of heart response to stimulation of these two nerves has been essentially qualitative. In the test description presented here, an attempt has been made to give a quantitative analysis of this heart control system.

BIOLOGICAL REVIEW

The regular beat of the heart is self-controlled by the "pacemaker," the SA (sinuauricular) node, lying in the upper right chamber of the heart, the right auricle. From here a depolarization wave is sent through the heart muscle, causing it to contract (70 to 80 times per minute for humans, 130 to 140 times per minute for dogs). The heart rate is also controlled by other factors but it is primarily controlled by signals coming directly from the brain through the vagus and sympathetic nerves. There are four nerve bundles, the left and right sympathetic and the left and right vagus. Fibers from both sympathetic nerves and the right vagus nerve terminate in the close proximity of the SA node, while fibers of the left vagus terminate at both the SA node and the AV (auriculoventricular) node. Very little is known about the AV node except that it is possible to produce a "block" in this node and thereby stop electrical conduction from the SA node to the lower chambers of the heart, the ventricles. The connection of these nerves to the nodes is not direct, but is made by means of chemicals secreted from the nerve endings. The secretion of adrenalin from the sympathetic nerves causes an increase in heart rate, while the secretion of acethylcholine from the vagus causes a decrease. A more complete explanation of the heart and its control can be found in physiology and medical texts.

THEORY

Since the heart is a dynamic system whose rate changes with stimuli and time, it lends itself very well to study by the analog computer. To put the results of the tests in a form suitable for analog computation required studies of available qualitative data. The steady-state heart rate as a function of the stimulus frequency was then expressed as follows:

$$HR = (HR_0 + Af_1)/(1 + Bf_2) \text{ beats per minute} \quad (1)$$

where

HR = heart rate
HR_0 = heart rate with no stimulus applied
f_1 = frequency of sympathetic stimulus, cps
f_2 = frequency of vagal stimulus, cps
A = experimentally determined coefficient relating steady-state heart rate to stimulus frequency f_1
B = similar coefficient relating heart rate to f_2

Here again, since the system is nonlinear, we see advantages of analog computer techniques.

EXPERIMENTAL METHODS

The experiments performed in preparation of this article were all conducted with the use of facilities of the Cardio-Vascular Laboratory at the Latter Day Saints Hospital, Salt Lake City, Utah.

In tests conducted, mongrel dogs were anesthetized with nembutal. After the nembutal had taken effect, the dogs were placed on the operating table and various test transducers were attached. Arterial blood pressure was recorded from the aortic arch just outside the left ventricle by means of a pressure

Essentially full text of the second prize paper for the Students Institute Prize, 1959-60. Recommended for publication by the AIEE Educational Publications Committee.

R. M. Gardner, Student Member AIEE, formerly a student at the University of Utah, Salt Lake City, Utah, is now with the U. S. Army.

gauge. This pressure in an electrical form was recorded on one channel of a multichannel tape recorder. The variation in blood pressure is very important because the heart rate can be determined from the pressure pulse of each heartbeat.

The electrocardiogram, or EKG, represents a graph of the depolarization or changing potential of the heart each time it beats. The EKG can be used to determine heart rate, but was used in the experiments conducted to detect heart "blocks" caused by stimulating the left vagus, as mentioned.

Since the vagus and sympathetic nerves act as primary control links to the heart, if all four nerves are severed this will essentially isolate the control of the heart so that external stimulation of these nerves will simulate control signals from the brain.

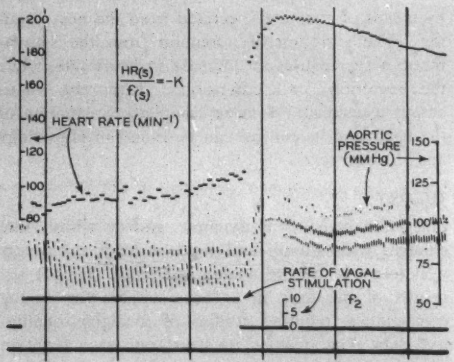


Fig. 1. Effect of stimulation of right vagus nerve on heart rate and arterial pressure

The nerve to be stimulated was placed across two platinum–irridium electrodes which were connected to a stimulator through an isolation transformer. The effect on heart rate resulting from stimulus of the vagus or sympathetic nerves depends not only upon the frequency of stimulus, but also upon the magnitude and duration of each stimulus pulse. These variables were easily controlled. However, the problem of electrode placement was more difficult to control and made quantitative comparison of response to stimulation of any two nerves difficult. Upon application of the stimulus an analog voltage, f_1 or f_2, proportional to the frequency of stimulation, was recorded on the tape to provide an analog "stimulus" which was later used for data reduction and simulation.

The multichannel FM magnetic tape recorder is an extremely valuable tool for medical research; besides providing storage for valuable data, the tape recorder allows the investigator to concentrate on the task of recording the basic data. Then, at some later time, the desired results can be computed from the tape.

Following each experiment the data obtained were recorded, by means of a mechanical oscillogram, on a photographic tape which allowed the experimenters to study the experiment and compute results. A typical section of recording film is shown in Fig. 1, with each of the traces appropriately labeled. The vertical lines are 10-second time markers.

The heart-rate indicator shown in Fig. 1 was obtained by programming the analog computer to produce a voltage proportional to the interval between pressure pulses; then, taking the reciprocal of this voltage, an output voltage proportional to the heart rate, but delayed by one beat, was obtained. By calibration of this voltage, the heart rate at any time could be determined by use of a scale, as shown in Fig. 1.

RESULTS

Determination of Steady-State Coefficients

Using the heart rate equation stated earlier (equation 1), the steady-state coefficients can easily be determined experimentally.

$$A = (HR_1 - HR_0)/f_1 \tag{2}$$

$$B = (HR_0 - HR_2)/HR_2 f_2 \tag{3}$$

where

HR_0 = heart rate with no stimulus applied
HR_1 = heart rate with only sympathetic stimulus
HR_2 = heart rate with only vagal stimulus
f_1, f_2 = frequency of stimulation of sympathetic and vagus, respectively

This information was easily obtained from records similar to Fig. 1.

Fig. 2 shows typical plots of A and B vs. f_1 and f_2, respectively. Note that as the frequency of stimulus f_1 to the sympathetic nerve is increased, the coefficient A becomes smaller at about the same rate that f_1 increases. Here, a condition for maximum heart rate is represented. Thus we see, as in many electric systems, that a saturation condition exists.

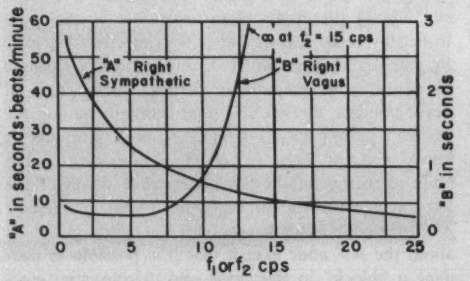


Fig. 2. Steady-state coefficients as a function of frequency

As may be noted from the plot for B, it goes to

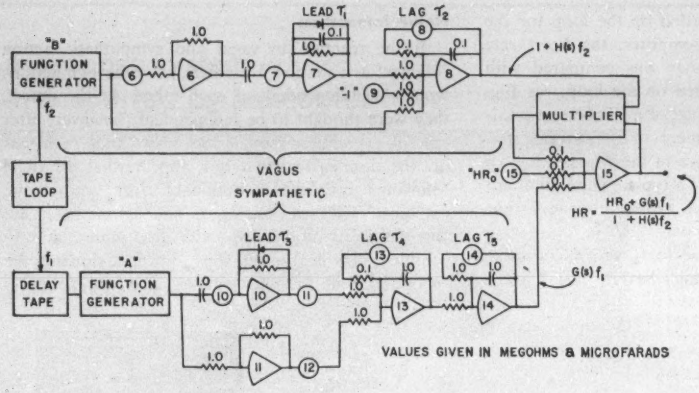


Fig. 3 Analog computer diagram

infinity at $f_2 = 15$ cps. This is a condition of cardiac arrest or of the heart stopping its action.

No systematic differences in the response to stimulation between right and left vagus and between right and left sympathetic nerves were observed. Exact comparison of absolute amplitude of response to stimulation of two nerves is made difficult by the fact that any variation in the electrode placement may result in variations in the number of fibers stimulated. However, in general it appears that stimulation of the right and left nerve (vagus or sympathetic) at 1 cps produces essentially the same response as stimulating either the right or left nerve at 2 cps. For this reason, it appears justifiable to treat the right and left nerves as part of a single system as far as their effect on the heart rate is concerned.

Dynamic Simulation

All analysis and discussion thus far have been on steady-state response of the heart. In order to provide a more complete quantitative analysis, it is necessary to make a study of the system's dynamic responses.

Since the coefficients A and B are dependent upon frequency variation of f_1 and f_2, respectively, it is convenient to work in the frequency domain instead of the time domain and express equation 4 in Laplace transform notation. Therefore

$$HR(s) = [HR_0 + G(s)f_1]/[1 + H(s)f_2] \quad (4)$$

Vagus

The equation for the heart rate with only vagal stimulation is

$$HR_2 = HR_0/[1 + H(s)f_2] \quad (5)$$

where it was found experimentally that $H(s)$ could be expressed in equation form as

$$H(s) = B(1 + \tau_1 s)^*/(1 + \tau_2 s) \quad (6)$$

where B is the steady-state coefficient (Fig. 2), τ_1 and τ_2 are time constants, and s is the Laplace operator.

The "lead" term $(1 + \tau_1 s)^*$ is marked with an asterisk to indicate that it is present only when frequency f_2 is increasing; i.e., when the stimulus f_2 is turned on. The term $(1 + \tau_2 s)$ represents a "lag," and in this equation it represents the exponential return of the heart rate to HR_0 after the stimulus was removed.

To find the time constant for vagal stimulation, a study was made of the photographic record to find a section of the record where a representative response was obtained. Then, when the desired section on the tape was located, pertinent information was rerecorded onto a continuous loop, providing a method of repeated observation of the information. For vagal simulation, the output of the heart rate meter and the analog voltage f_2, representing the stimulus frequency, were rerecorded on the loop. The analog computer was then programmed as shown in Fig. 3. The function generator provided the nonlinear coefficient B; the other sections are

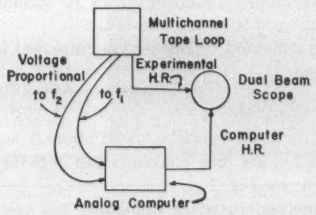


Fig. 4. Block diagram of simulating system

appropriately labeled. Since the lead term was to be present only on increasing f_2, it was necessary to include the diode as a feedback element of amplifier 7. For better simulation, and to expedite the procedure, the loop was played back at eight times normal speed.

Using the analog f_2 recorded on the loop for the "stimulus" of the analog computer, the heart rate as predicted by the computer was compared with the actual heart rate recorded on the loop; see Fig. 4. This was done with the use of a dual-beam oscilloscope and by the adjustment of appropriate potentiometers until the changes in the two heart rates were identical. The results of a typical simulation are shown in Fig. 6 with some typical time constant values given.

The "front edge" response to f_2 varied considerably even on the same dog. Several ideas were

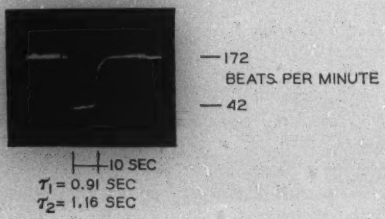


Fig. 5. Results of a typical vagal simulation

tested but none seemed to provide a suitable answer. Therefore, it must be concluded that this error was due to experimental method or more likely the action of some unknown mechanism.

Sympathetic

The equation for heart rate with sympathetic stimulation is

$$HR_1 = HR_0 + G(s)f_1 \qquad (7)$$

From experimental data it was found that no change in heart rate occurred for about 1.5 seconds after application of the stimulus. Then with a rather slow rise the heart rate approached a new value, where it remained until the stimulus was removed. Upon discontinuing sympathetic stimulation, the heart rate decreased slowly, requiring 20 to 30 seconds to return to the control heart rate HR_0.

Using a method similar to that employed for vagal simulation

$$G(s) = [A\epsilon^{-Ts}(1+\tau_3 s)^*]/(1+\tau_4 s)(1+\tau_5 s) \qquad (8)$$

where T is a fixed time delay of about 1.5 seconds, τ_3, τ_4, and τ_5 are time constants and A is the steady-state gain; see Fig. 2.

The methods used in simulating the sympathetic response are much the same as those used for vagal response. To provide the delay time, a delay tape was used. The "stimulus" $f_2\epsilon^{-Ts}$ was then applied to the computer. Other elements have functions similar to the vagus simulation. A typical stimulation is shown in Fig. 6 and representative time constants are $\tau_3 = 4.9$–19.6 seconds, $\tau_4 = 1.78$–2.7 seconds, $\tau_5 = 8.4$–27 seconds.

Nerve Interaction

If the reaction to vagal and sympathetic action followed as equation 4 predicts, then the two actions would be independent of each other. At the outset, they were thought to be independent; however, after careful experimentation it was found that such was not the case. From the data it appears that the vagal (slowing) response is dominant over sympathetic response. Thus, if the vagus and sympathetic are stimulated simultaneously with the same effective stimulus, the heart will slow down, following the "command" of the vagus nerve. This interaction is

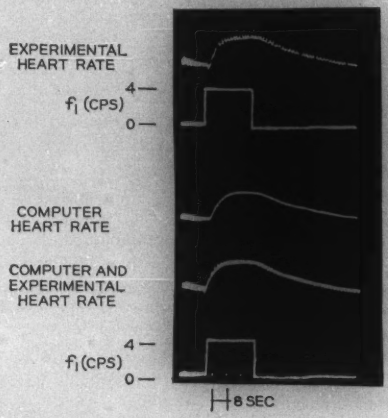


Fig. 6. Results of a typical sympathetic simulation

presently being studied in detail and it appears that soon a satisfactory solution will be made.

CONCLUSIONS

The goal of the project described in this article was to obtain a transfer function for the sinuauricular node of the heart, having both vagal and sympathetic stimulation as the inputs and the heart rate as the output.

The goal was not completely attained, however, because of the presence of vagal and sympathetic interaction. The reasons for the test were purely academic; it was hoped that the equations found might serve to give some insight into the basic biological processes (chemical reactions, diffusion, etc.) of the SA node.

This article deals with but one link of the heart control system. The performance of the complete system is influenced by the transfer functions of each of the system's components. As in the case of any closed-loop system, performance can be determined only by simultaneous solution of all the system's equations. The ultimate goal, therefore, is to obtain transfer functions for each of the system's components.

PROGRESS IN TECHNOLOGY

Air defense system is transported by helicopter

Helicopters sweep in on a mountain battlefront transporting the Helilift air defense system which co-ordinates firing of Hawk (left foreground) *and Nike* (left and right background) *guided missile batteries*

A battle commander can be provided with an electronic capability for co-ordination and concentration of missile fire power against enemy aircraft with the Helilift, a helicopter-transportable air defense system. Developed for the Army Signal Corps by Hughes Aircraft Corp., each system is installed in five or more heavy-duty plastic and aluminum shelters that can be moved rapidly from one military position to another as the need arises.

The system consists of one "operations central" and four or more coder-decoder units. From operations central, the commander monitors the air battle and assigns targets to his Nike or Hawk missile batteries by sending digital messages through the coder-decoder units. These units, located at widely dispersed missile sites, also transmit the status of each battery to the commander so that he knows at a glance the capability of his entire missile defense.

Giant wafer coils focus microwave beams

Wafer or flat wire coils, developed over the past 12 years through research and development, have emerged from the laboratory for practical application in such diverse fields as the highly competitive automotive industry and the demanding nuclear research fields. This has been the experience of Sylvania Electric Products Inc.

Much of the developmental work was initiated by continued demands, both military and commercial, for smallness, lighter weight, higher operating temperatures, and automated construction for increased reliability in electromagnetic devices. In the transformer field alone, much of the past conventional construction methods depended largely upon hand operations, and despite intensive efforts little success had been achieved in the mechanization of production.

The need for transformers in mass quantities has made it imperative that improved manufacturing techniques be developed. From a military standpoint, mechanization is even more important to prevent bottlenecks in times of emergency. With this goal in mind, a complete study of the product, design, and method of manufacture was made, with the result that wafer coil concept of design and production was evolved.*

This method provided uniform, flat wafer-type coils, each with self-contained terminals. By stacking the individual coils together with proper connections, various combinations of turns and equivalent wire sizes can be obtained. Of greater importance, the individual pieces lend themselves to repetitive operations, and this is the first step for mechanized production. Test of samples showed equivalent electrical performance with sizable gains in the reduction of physical size and weight.

The first step in making wafer coils is the winding of metal foil into a roll. The foil is either precoated with an adhesive-type insulator or a spacer such as Kraft paper, Mylar, or a similar film to separate the turns. If a spacer is used, the wound roll is impregnated with wax, rosin, or varnish. The winding is started by using a coil form on an arbor. A copper terminal tab is placed across the width of the winding foil and fastened to the coil form at the proper position. Following this, the correct number of turns are wound and, at the end of the winding, a finished terminal tab is attached across the entire width of the foil. The wound roll is then wrapped and impregnated to hold it intact. The impregnated roll is next sliced into wafers with the thickness or width depending upon the cross-sectional area desired for the conductor.

In the production of coils of this size, the need for the meticulous handwork of fine wire protection, with its special tapes to form the joint to a heavier lead wire, is eliminated because each individual wafer has a heavy-duty terminal attached during the winding operation.

After slicing and burr-removal processing, the wafers are ready for assembly.

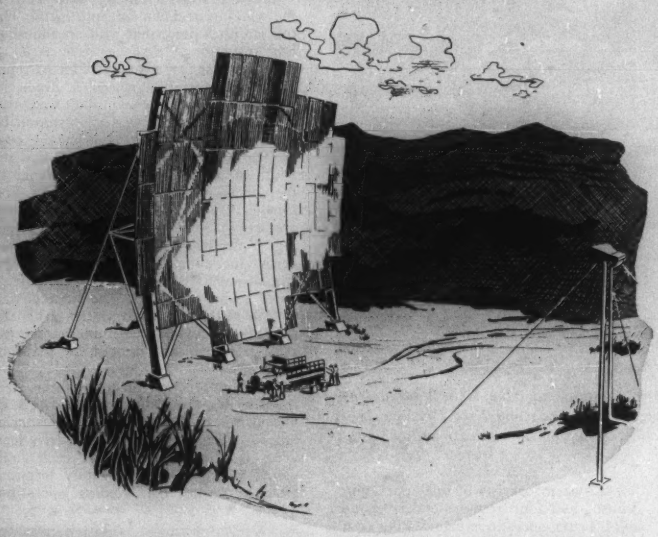
In the area of large focusing devices, such as those used in high-powered klystrons and focusing coils for research activities (magnetohydrodynamics, biological research, plasma research, accelerators, etc.), large coils of several feet in diameter have been made in many form factors to meet the most stringent specifications of complex systems. Wafer techniques in these large sizes eliminate

* Work in this development was done under Air Force Contract AF33 (616)-486, directed by Wright Air Development Center.

the need for expensive and complex coil forms which ordinarily are used with wire-wound types. In addition, the large type of coil offers the ability of being machined after it is formed and can also be cooled by adding water-cooled end plates without any danger of "hot spotting."

Wafer coils are now made in sizes of 1 inch to 10 feet in diameter and from 1 ounce to over 1 ton in weight. Their inherent advantages over conventional wire continue to expand daily the applications in the magnetic component industry.

Tropospheric scatter antenna makes world-wide television practicable



Boeing's new tropo-scatter antenna allows transmission of as many as 1,000 messages at one time

World-wide television transmission becomes economically feasible through use of a new tropospheric scatter communications antenna, according to its developers, The Boeing Co. Through use of such antennas, voice, television, and numerical symbols such as computer data, can be sent as far as 500 miles without signal boosters between points. By positioning reflectors strategically on ocean islands and specific points of land masses, instantaneous world-wide communication is possible.

Available with reflectors 30, 60, and 120 feet across, the antenna is assembled on site from only a quarter as many parts as conventional tropo-scatter antennas. Its construction is simplified through use of preformed and predrilled steel girders.

Tropospheric scatter technique uses successive layers of violently disturbed air some 20 miles up to bounce h-f radio waves to another antenna miles away. The force of as much as 100 kw of power at frequencies between 400 and 4,000 mc makes signal transmission by tropo-scatter techniques both steady and dependable.

The new Boeing 60-foot antenna can be erected by an 8-man crew in 50 hours.

New research programs cover a variety of objectives

News is released of two research programs: (1) that of the National Aeronautics and Space Administration (NASA) in collaboration with the Midwest Research Institute (MRI), who jointly announce a program to expand science, education, and industry in a 6-state Middle-West region; and (2) that of the National Science Foundation which plans Antarctic research activities.

Objectives of the NASA-MRI program are to increase the participation of university science departments in research and education and to stimulate industry to make use of the technology resulting from space exploration. MRI will work with universities and industries in Arkansas, Iowa, Kansas, Missouri, Nebraska, and Oklahoma. The NASA, with a current budget of $1.8 billion, is engaged in research and development work for lunar and planetary exploration, communications satellites, propulsion systems, and related vehicle programs. Teams of scientists and engineers will visit leading NASA scientific installations and be briefed on the NASA program, and then visit the universities.

As an example of anticipated practical results, Dr. Max Thornton, technical director of MRI, and in charge of the over-all program, says, " . . . if NASA should develop a ceramic material as a consequence of space research, the material might be suitable for use by an automotive, container, or boat manufacturer as a coating material. The role of MRI will be to make this kind of information about NASA discoveries available to industry and to supply it to NASA." University and business people have shown enthusiasm for the effort, and impressive results are expected. Inquiries may be directed to Dr. Charles N. Kimball, president, Midwest Research Institute, 425 Volker Blvd., Kansas City., Mo.

The National Science Foundation (NSF) announcement concerns a new group of 27 grants and contracts for U.S. research in Antarctica, totaling approximately $1.5 million. Work will include a series of meteorological rocket firings. The rockets will be launched into the upper atmosphere to heights of more than 35 miles, to investigate temperatures and winds. The work will be done by personnel of the Schellenger Research Laboratories of Texas Western College. The soundings of temperatures and winds, never before systematically measured in the stratosphere at high southern latitudes, will be conducted at the same time as similar measurements in other parts of the world through the Meteorological Rocket Network, and will be correlated with world-wide stratospheric wind measurements. ARCAS rockets, manufactured by the Atlantic Research Corporation, Alexandria, Va., will be used. Each rocket assembly includes a parachute with a 5-pound instrument package, ejected at the top of the rocket flight from which point it transmits information as it descends.

Under another grant, meteorological research will be carried on by the U. S. Weather Bureau using U. S. Navy support aircraft to observe and photograph variations in types and extent of sea ice cover in Antarctic waters. This will be done to gain experience in ice cover analysis, to aid in the interpretation of data from forthcoming polar satellites, and to learn more about how the ice belt affects surface temperatures on the continent.

Another project will be carried out by Dr. Madison E. Pryor, who will study invertebrate land animals and correlate them with ecological studies that have been conducted at U. S. stations. The 16-month biological investigation will take place at Mirny, the main base of the U.S.S.R. Antarctic research expedition. (Each year the U. S. and the U.S.S.R. exchange scientists at Antarctic bases.) In the new grant special attention will be paid to determining how land invertebrates have adapted themselves to the extreme climatic conditions.

Further information concerning NSF

projects and a list of grants and contracts for Antarctic scientific research may be obtained from the NSF, 1951 Constitution Ave., NW, Washington 25, D. C.

Nuclear energy society established in Great Britain

On January 1, 1962, the British Nuclear Energy Society will be instituted in succession to the British Nuclear Energy Conference. The Conference was established in 1955 by the Institutions of Civil, Mechanical, Electrical, and Chemical Engineers, and the Institute of Physics, joined later by the Iron and Steel Institute, the Institutes of Metal and of Fuel, and the Joint Panel on Nuclear Marine Propulsion.

The Conference publishes in its journal papers on nuclear energy presented to the constituent societies, keeps members of the various societies informed of meetings, and sponsors meetings on nuclear energy.

To provide a central forum for the discussion of nuclear energy the new Society was established. The Institution of Civil Engineers have made their premises available for the monthly meetings, and a regular program of papers, lectures, symposia, and informal discussions is being planned. Views on all aspects of nuclear energy will be discussed, including the fields of medicine and agriculture. The *Journal* will continue to be published.

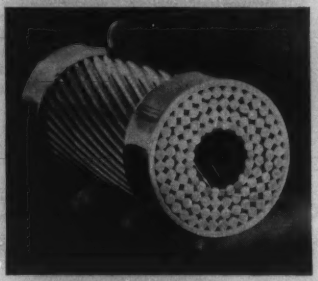
Application forms for membership may be obtained from the Secretary at 1-7 Great George St., London, S.W.1.

Large-diameter conductors tested

A big conductor, 2.136 inches in diameter, has been manufactured in answer to future power transmission needs, which are foreseen in the growth rate of the electrical industry, expected to double in the next 10 years. Because increasingly large blocks of electric power will have to be transmitted over greater distances, large-capacity tie lines to connect two or more power company systems and government-owned electric generating groups are being planned. These will permit exchange of power during peak demand periods and in defense emergencies.

Any great intersystem ties or a possible nationwide "super" electrical grid are considered feasible only with ehv transmission systems. Bonneville Power Administration's (BPA) novel hollow-core conductor cable was designed to meet 460,000- to 500,000-volt power transmission demands, and is being tested, together with five other types of conductors, in an experimental section of the line near Portland, Oreg. Supplementing the present 345,000-volt circuits with the much higher voltage is expected to lessen difficulties of access through the mountain passes of the Cascade range.

The test program has two objectives: to investigate the practicability of producing large-diameter conductors of expanded design (with air spaces which increase the over-all diameter without increasing the metallic cross section);



and to determine the stability of various conductor designs under normal field-handling conditions.

Reason for the conductor's large diameter: at high voltage, corona becomes a significant factor; the ionized air surrounding the surface of the conductor leads to power loss and radio and television interference. One way of reducing this electrical pressure—and hence reducing corona—is to increase the conductor diameter.

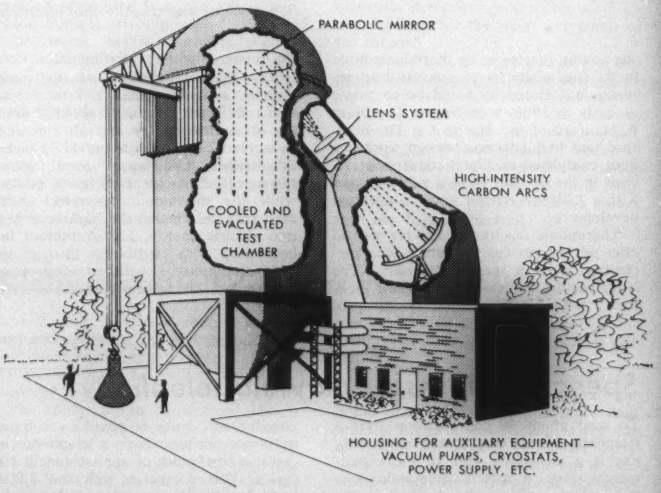
Olin Conductors, of Olin Mathieson Chemical Corp., developed and manufactured the BPA conductor, which consists of 90 aluminum wires laid spirally in three layers around a central "core" layer. The inside layer is made by alternating 12 steel wires and 12 shaped aluminum wires to form an interlocked cylindrical structure containing nothing but air. It contains no parts that would increase weight without contributing to the strength and current-carrying capacity; the number of steel-reinforcing wires in the core makes it the strongest of the six to be tested. The cross-sectional area is of 2,715,000 circular mils and weighs 3.268 pounds per foot. Its rated strength is 82,000 pounds, and its strength-weight ratio, 25,300.

Carbon arcs simulate solar radiation

Solar radiation beyond the earth's atmosphere can be simulated precisely in environmental space chambers bathed in both visible and invisible light from a bank of carbon arcs. This information was recently confirmed in a series of tests by National Carbon Co. Engineers in the company's development laboratories state that such chambers should prove valuable research tools in the earth-bound evaluation of space vehicles and equipment.

Using a Perkin-Elmer recording spectrophotometer, National Carbon engineers measured the spectral energy distribution of radiation from the carbon arc all the way out to 150,000 angstroms. Data were then plotted on a curve showing the spectral energy distribution of the sun outside the earth's atmosphere from 2,500 to 60,000 angstroms. This includes from 98 to 99 per cent of the sun's energy output and the two curves were found to follow each other closely over the entire range.

Space equipment designers can now

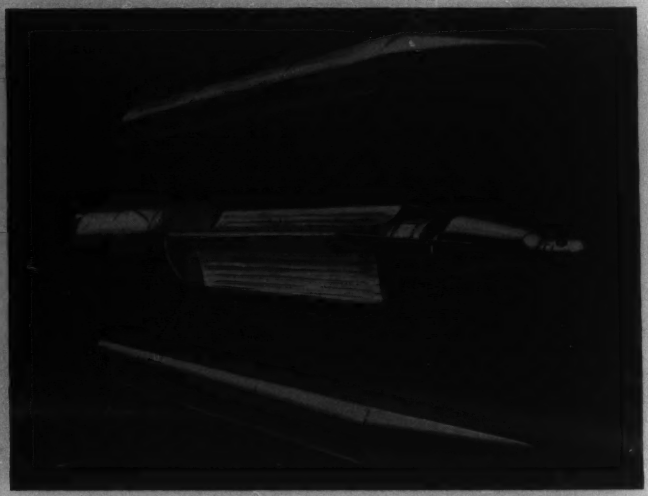

PARABOLIC MIRROR
LENS SYSTEM
HIGH-INTENSITY CARBON ARCS
COOLED AND EVACUATED TEST CHAMBER
HOUSING FOR AUXILIARY EQUIPMENT — VACUUM PUMPS, CRYOSTATS, POWER SUPPLY, ETC.

Artist's conception of what a typical environmental space chamber might look like shows blockhouse for auxiliary equipment at right. Carbon arcs operate outside the chamber so their heat is not a problem. Their spectral energy is beamed into the test area with a lens system and a parabolic mirror

use banks of carbon arcs with no filters or added energy in test chambers to simulate conditions of solar radiation in outer space. Much of the sun's energy is absorbed by the atmosphere and never reaches the earth. Once space vehicles are above an altitude of about 300 miles, however, the atmosphere is so rarified as to absorb none of the sun's energy. Then, solar radiation becomes a critical factor in the operation of the vehicle, component parts, and such devices as solar cells.

Solar-cell evaluation will be conducted according to specifications developed by AIEE. The energy standards for such tests are based on Johnson's spectral energy distribution of the sun outside the earth's atmosphere, published in the 1960 *Handbook of Geophysics.*

Thermionic reactor held feasible as early as 1966



Artist's conception of new atomic reactor developed by Martin which changes heat directly into electricity

An atomic reactor using thermionic units in its fuel elements to convert heat directly into electricity could be operating as early as 1966, according to Dr. Clare P. Stanford of the Martin Co. Dr. Stanford said that advanced design work has been completed on direct conversion systems in the 60- and 300-kw power ranges with a 2,000-kw reactor under conceptual development.

Thermionic reactor systems are said to offer advantages for the future over mechanical units in space applications. The latter require a turbine to generate electricity while a thermionic system produces energy without moving parts.

The 300-kw thermionic reactor development at Martin uses 250 thermionic fuel rods, each producing about a single kw of electric energy and all contained in a core 22 inches high and 11.75 inches in diameter. A liquid metal passes through the reactor core as a coolant while the thermionic converters inside each fuel rod change the high core heat into electric energy. Liquid lithium has been used with circulation through the core accomplished with an electromagnetic pump. The system operates at about 1,400 F.

Speech compressor may aid telephony

To send about 30 conversations over a telephone circuit that now handles only one is a possibility now in the experimental stage. A speech compression system called a "formant vocoder" is the object of a U.S. Army Signal Corps contract awarded the Research Division of General Dynamics/Electronics.

By reducing human speech to the bare minimum of its essential elements, the vocoder will make it possible to transmit voice messages over a telephone circuit in a bandwidth of approximately 100 cycles. This compares with the 3,000-cycle bandwidth normally used in telephone transmission. Thus the possibility of enormously enlarging the capacity of the telephone circuit.

The purpose of the studies under the contract is to analyze the physical characteristics of speech so that vocal communication can be described in terms of a relatively small number of principal resonances, of formants, and of their modes of intermixture and change.

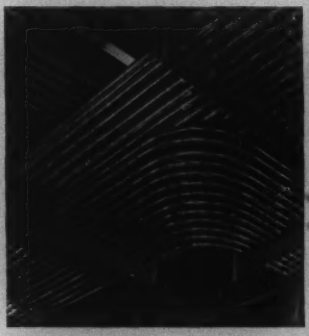
In the formant vocoder speech compression system the speech sounds are analyzed and processed to emphasize the principal formants and eliminate all nonessential elements. The resulting signal is then transmitted in the same manner as a normal telephone message, but using a much narrower portion of the spectrum. At the receiving end the voice is reconstituted by adding certain synthetic noises to the formants, so that the end result sounds remarkably like the original speech.

Development work will be under the technical direction of the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J. The $94,155 contract was awarded by the U.S. Army Signal Supply Agency, Fort Monmouth.

Powerful strip mill uses color coding

Exposed conduit painted bright red distinguishes it from pipe used for other purposes. The most extensive use to date of this device is announced for the 80-inch hot strip mill constructed at River Rouge, Mich., for Great Lakes Steel Corporation.

To reduce the cost of painting, and the possibility of injury to workmen, the color-coded conduit was painted before installation. The order called for 1,500,000 pounds of the red conduit in sizes ranging from ¾ inch to 4 inches. After the pickling process, rigid steel conduit is galvanized by the Sherardizing process, in which zinc is alloyed to the conduit walls and threaded ends. It is then immersed in a bath of corrosion-resisting MVC-1 polyvinyl, to which the color pigments have been added, and moved slowly through ovens in which the finish is baked dry and hard.



Complexity of electric conduit installation for new 80-inch hot strip mill illustrated. Beneath straight runs, 3 deep and 14 wide, are additional curved runs, 2 deep and 12 wide

For the Great Lakes Steel mill, which

has a capacity of 3,600,000 tons a year, the conduit was shipped on flat bed trucks in bundles of 2,000 pounds, loaded on 4×4 beams for fork lift handling. This kept unloading time at a minimum. Approximately 25 per cent of the conduit was bent at the job site for installation.

Work on the mill was started in March 1960, and completed in September 1961. Described as the world's fastest and most powerful strip mill, its operations are entirely programmed and regulated by an electronic computer system.

The color-coded conduit was supplied by National Electric Div., H. K. Porter Co., Inc.

Ancient Chinese theorem aids Air Force arithmetic

A new kind of arithmetic taken from the 2,000-year-old theorem of a Chinese philosopher promises to make computer operations 20 times faster. Scientists at Lockheed Missiles and Space Company are working on the new "modular arithmetic" for the Air Force under contracts calling for theoretical study and design of computer circuits.

No change in the computers is necessary; the speed-up is achieved by a different way of presenting and manipulating information. With the new arithmetic, numbers need not be "carried over" from one column to the next. This means that calculations can go just as fast as the computer can run. With ordinary arithmetic, the computer must wait for the "carries" to catch up with the main calculation.

In a very much simplified explanation scientists say that, whereas ordinary arithmetic computation relies on the decimal system, a set of arbitrary rules for handling numbers, modular arithmetic uses a more complicated set of rules; it is something like converting a problem into algebra, solving it, and turning the answer back into numbers.

The new arithmetic could be useful where extreme speed is required, according to Dr. R. I. Tanaka, head of Lockheed's logical design group, which has charge of the project. In space flight, for example, a spacecraft computer might solve navigation problems four or five times as fast as conventional calculation, of advantage in situations like re-entry into the atmosphere, where great precision in a limited time is required.

With the advantage of its speed, and since costs of computer time run to hundreds of dollars an hour, modular arithmetic could handle scientific computations now prohibitive in cost and time.

The new arithmetic has weaknesses: it is ideal for addition, subtraction, and multiplication on computers, Dr. Tanaka says, but for division it is no better than existing methods. Its specialty seems to be multiplication. Conventional computers do not actually multiply but get results by making a vast number of additions. With modular arithmetic, the computer multiplies in a single operation.

Work behind the Iron Curtain was responsible for Lockheed's interest in modular arithmetic. The studies of a Czechoslovakian scientist, published in a journal of his country, first caught the attention of Howard Aiken, head of the Harvard Computation Laboratory and a consultant to Lockheed's scientific laboratories. Lockheed has greatly advanced the technique under its Air Force contract. Results of the study may be construction of a special computer for use solely with modular arithmetic, or adaptation of modular arithmetic methods for use on conventional computers.

Bio-power devices show promise as power sources

Devices known as bio-power units which convert "life-energy" into usable electric power have been in operation for more than a year at Magna Products, Inc. The new sources of electric energy have so far been developed in three different models. The first is a bio-battery that uses natural minerals and organic matter contained in ordinary sea water. Billions of bacteria consume these nutrients, producing an electric potential between the poles of the battery.

The second type is the bio-fuel cell using organic matter and air. The third is a bio-solar cell that makes use of photosynthetic organisms that convert solar energy directly into electricity at efficiency levels that may ultimately be far above those achieved by any other known device, according to Magna Products.

Models of these devices are already generating sufficient power to operate radio beacons, signal lights, or other apparatus at sea. But this is only the first stage, according to Dr. Rohrback of the developing firm.

"We have now demonstrated the feasibility of an entirely new technique for generating power," said Dr. Rohrback. He explained that the only limitation on the variety of "fuels" that may be used in a bio-battery is the availability of bacteria or organisms that can use a particular mineral or compound.

"It seems highly probable," commented Rohrback, "that bio-power will contribute significantly to the electrial energy needs of man. Instead of using the fossil remains of a living organism, as in the case of coal or petroleum, we will use life energy as it occurs, drawing off enough for our purposes without disturbing the delicate reactions that make up the life process."

"We already have centuries of experience in putting bacteria and other forms of life to work in our behalf. In fact, a brewery would be in effect a power plant—if we were clever enough to extract in electrical form the energy that is produced through fermentation. Sugar,

The bacteria culture shown is producing electric power at Magna Products, Inc.

potatoes, vegetation, raw sewage, and a variety of other commonly available materials heretofore not usable as fuels may be ideal for the bio-power plants of the future."

Magno Products encountered the bio-power phenomenon in the course of its basic research into the fundamental causes of corrosion. One basic cause of corrosion in oil wells and ocean water pipelines is the electrochemical action of bacteria that cling to metal. By giving order to the action of the bacteria, Magna was able to tap the electric power that was being generated.

Bilateral-cable TV makes its bow

Simultaneous video and audio transmission and reception in both directions is now possible through the bilateral-cable system introduced by Entron, Inc., Bladensburg, Md. The system will have particular application to industry and schools and will permit instantaneous 2-way communication at a fraction of current costs. It will obviate the necessity of the separate TV cables between two locations, used under the present uneconomical method.

A vast film library of educational material—in conjunction with a planned program of adult or extension schooling—can be made available to the community through the cable system by the addition of electronic motion picture projectors.

With video tape machines, special cultural telecasts can be introduced into the home, minutes (or months) after their original performance. Group instruction or special classes may be offered simultaneously to advanced students or to bedridden youngsters throughout the community.

The new system was shown by the Entron Company recently in Washington, D.C., at the 125th anniversary exhibit of the U.S. Patent Office, sponsored by the Department of Commerce.

Superconductivity remains under high magnetic fields

Niobium-tin wire has been shown to remain superconducting in pulsed magnetic fields of up to 185 kilogauss in tests conducted recently by the National Bureau of Standards in co-operation with the University of Colorado. When extrapolated to zero measuring current, the critical field appears to be about 188 kilogauss at 1.6 K.

The experiments may lead to the development of superconducting magnets having high field strengths such as are required in a large number of scientific applications.

The wire used in the investigation was prepared in the Bureau's metallurgy laboratories by a swaging process to its final diameter of 0.50 mm. A niobium tube was packed with a powdered Nb-Sn mixture. Then, the tube was drawn or swaged into wire, after which individual specimens 12-cm long were treated at 1,000 C for 16 hours. The ends were acid-etched and tinned in a bath of molten indium after heat treatment. Current and potential leads were attached to the wire with indium solder.

NEW LIBRARY BOOKS

TRANSIENT CIRCUIT ANALYSIS. Y. H. Ku. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 1961. 441 pages, 6¼ by 9¼ inches, bound; $13.00. After a general discussion of linear electric and mechanical systems, the author reviews ordinary differential equations and the Routh-Harwitz criterion for testing the presence of positive real roots. Linear circuit analysis is then presented. A detailed discussion follows of the Fourier series, integral, and transform. A full treatment of the Laplace transform and the inverse transform is followed by an analysis of feedback control systems and stability studies. The remainder of the book covers the functions of a complex variable, transients in transmission lines, and the z-transform and sampled-data systems.

THERMO-BIMETALLE IN DER ELEKTROTECHNIK. F. Kaspar. VEB Verlag Technik, Berlin, Germany, 1960. 371 pages, 6¾ by 9½ inches, bound; DM 58.00. This translation of a Czechoslovakian book on thermostatic bimetals provides thorough coverage, beginning with the details of bimetal construction and the basic types of mechanisms utilizing bimetals. The author devotes a major part of the book to their use in protective devices for electric plants and installations. Subsequent chapters treat their use as control devices for a wide range of electric machinery, household equipment, etc., the processing of bimetals, and standards and testing. The calculations are aided by nomograms, and a considerable bibliography is given in several languages.

PRINTED CIRCUITS. J. M. C. Dukes. Macdonald and Company, Ltd., London, England, 1961. 228 pages, 5¾ by 8¾ inches, bound; 40s. Printed circuit techniques are discussed with particular emphasis on circuit and equipment design. Following a brief description of manufacturing processes, the author considers the preparation of the circuit information, materials for printed circuits, printed components for low and medium frequencies, strip transmission lines, and printed microwave systems. Appendixes describe testing procedures and specifications as well as some early printed circuit patents.

FUNCTIONAL CIRCUITS AND OSCILLATORS. H. J. Reich. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1961. 466 pages, 6 by 9¼ inches, bound; $12.50. The analysis and applications of electronic circuits that generate or employ pulses and nonsinusoidal waves are emphasized in this volume. In this connection the theory and characteristics of negative-resistance circuits and devices are presented in a comprehensive fashion. There is also a detailed treatment of the basic principles of sine-wave oscillators. Tube and transistor circuits are discussed in the same sections except where differences in characteristics make this treatment impractical. Throughout the volume, problems form an integral part of the presentation, and clarify the textual matter.

CROSSED-FIELD MICROWAVE DEVICES. E. Okress (editor). Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1961. 2 volumes, 6¼ by 9¼ inches, bound; $40.00. The state of the art of crossed-field microwave devices, in theory and practice, is presented. In the papers included the authors present the fundamentals of all existing important types of crossed-field devices, the problems posed by each element of the devices in practice and in theory, and the means available for solving these problems. Because most of the recent developments of crossed-field devices have not dealt with the magnetron itself, but with the newer types such as the magnetron amplifiers and electronically tunable wide-band oscillators, these topics occupy a substantial part of the book.

WERKSTOFFPRÜFUNG MIT ULTRASCHALL. J. Krautkrämer, H. Krautkrämer. Springer-Verlag; Berlin, Germany, 1961. 501 pages, 6¾ by 9¼ inches, bound; DM 64.50. A comprehensive treatment of the use of ultrasonics for materials inspection is given in this book. Methods and equipment are described, including the production, propagation, and reception of ultrasonic waves. The greater space is devoted to metals, but other materials are also covered, including ceramics, rubber, concrete, wood, and certain foodstuffs. Brief sections are devoted to the determination of the thickness of walls and coatings, and to diagnostic applications in medicine. A bibliography of 330 items is appended.

GROSSEN UND EINHEITEN DER ELEKTRIZITATSLEHRE. Johannes Fischer. Springer-Verlag; Berlin, Germany, 1961. 122 pages, 6¼ by 9¼ inches, bound; DM 16.50. This is a text on electrical values and units intended for physicists and electrical engineers. Following some fundamental principles on the subject, the characteristic values in electric and magnetic fields are listed according to a deductive method. Emphasis has been put on the most used practical units and the CGS-units. The attached tables assist the practical engineer in transferring from one type of equation to another and from one system of units to a different one.

ENGINEERING MANAGEMENT AND ADMINISTRATION. Val Cronstedt. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1961. 345 pages, 5½ by 8½ inches, bound, $8.50. Administrative methods for engineering departments are described in this handbook, which deals with the traditional responsibilities of the administrator and of the development and design engineering departments. Procedures for budget administration, personnel acquisition and training, distribution lists, engineering records, experimental shop and test operations, patents, design changes, and parts listing are outlined simply and clearly.

ELECTRIC UTILITIES—COSTS AND PERFORMANCE. William Iulo. Washington State University Press, Pullman, Wash., 1961. 180 pages, 6¼ by 9¼ inches, bound; $7.50. By the use of statistical techniques the author seeks to find the relation between unit electric costs and certain operating, market, and historical factors. The data cover the 6-year period 1952-57 for 186 electric utilities. The results of the study show varying degrees of utility efficiency and inefficiency.

ERDUNGEN IN WECHSELSTROMANLAGEN ÜBER 1kV. Walter Koch. Springer-Verlag; Berlin, Germany, 1961. 228 pages, 6¼ by 9¼ inches, bound; DM 22.50. This book on the principles and practice of grounding for a-c plants above 1 kv covers the design of single and compound grounds under various conditions, measurement and testing of grounds, and installations for both power plants and substations. Special topics include loss currents to earth, the earth as a conductor, short circuits, and lightning arresters.

DIE PRAXIS DER INDUKTIVEN WARMBEHANDLUNG. Kurt Kegel. Springer-Verlag; Berlin, Germany, 1961. 167 pages, 6¼ by 9¼ inches, bound; DM 31.50. This book presents a description of the methods and equipment for the application of induction heating to heat-treating operations. The several chapters include both the electrical and mechanical details of the equipment, causes and avoidance of breakdowns, safety devices, examples of procedure, metallurgical aspects, and brief notes on other uses of induction heating devices.

CURRENT TRENDS IN SCIENTIFIC RESEARCH. Pierre Auger. United Nations, New York, N. Y., 1961. 245 pages, 8½ by 11 inches, bound; $6.75. This report prepared by the United Nations and its specialized agencies surveys developments in scientific research in such areas as the fundamental sciences, the earth and space sciences, the food and agricultural sciences, fuel and power research, and industrial research. The organizational structure of scientific research is also examined, and recommendations are made regarding the dissemination of scientific knowledge and its application to peaceful ends.

ELECTROSTATIC PROPULSION (PROGRESS IN ASTRONAUTICS AND ROCKETRY, VOL. 5) D. B. Langmuir et al. (editors). Academic Press; 111 Fifth Ave., New York 3, N. Y., 1961. 579 pages, 6¼ by 9½ inches, bound; $5.75. Specialists have presented the papers in this volume with special regard to conflicting theories on given problems. One session at the conference was on ion generation, with papers on the duoplasmatron and surface ionization. Ion acceleration and impact effects deal with ion beams and ion bombardment. Problems of neutralization are studied next and, finally, techniques and testing are dealt with in papers on hot-water colorimeter measurement, beam diagnostic techniques, propulsion devices, and ion engine testing.

ENERGY CONVERSION FOR SPACE POWER. N. W. Snyder (editor). Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1961. 779 pages, 6¼ by 9½ inches, bound; $7.25. This book is volume III in the American Rocket Society's *Progress in Astronautics and Rocketry*, and is the first of two volumes of papers from the ARS Space Power Systems Conference held with the co-operation of AIEE in September 1960. The papers are concerned with the scientific and engineering principles involved in the conversion of energy into electric energy. They deal with thermoelectricity, thermionics, photovoltaic cells, electrochemical cells, dynamic engines, magnetohydrodynamics, and electrostatic generators.

SHIELDING MATERIALS FOR NUCLEAR REACTORS. A. N. Komarovskii. Pergamon Press, Inc., 122 E. 55 St., New York 22, N. Y., 1961. 145 pages, 5½ by 8¾ inches, bound; $9.50. The results of Russian investigations into practical methods for constructing radiation shielding for nuclear reactors and accelerators are presented. Full details are provided on the different types of concrete which have been used, together with their properties and strength. Particular attention is paid to heavy and hydraulic concretes, and information is given on variation in attenuation which results from varying the type of concrete.

SPACE POWER SYSTEMS. (PROGRESS IN ASTRONAUTICS AND ROCKETRY, VOLUME 4.) N. W. Snyder (editor). Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1961. 632 pages, 6½ by 9½ inches, bound; $6.00. The papers included in this volume constitute a selection of technical papers taken from a Symposium of the American Rocket Society held at Santa Monica, Calif., in 1960, in co-operation with AIEE and other organizations. They are grouped in four sections, the first three of which involve systems based on the three primary sources of energy of practical value: solar, nuclear, and chemical. The fourth section is devoted to future requirements for space power. There is no index.

TECHNICAL LITERATURE

For copies of publications listed please write to the addresses given.

ELECTRONICS MATH SIMPLIFIED. This book by Alan Andrews is designed for the student, technician, or junior engineer who requires an understanding of mathematics as it relates directly to electronics theory. The text section includes chapters on resistance, wire measurements, capacitance, inductance, frequency, vacuum-tube characteristics, transformers, modulation, meters, antennas, etc. No mathematics beyond basic algebra and trigonometry is presented. Practice exercises are included in each section, with answers in a special appendix. The 224-page book is priced at $4.95, and is available from Howard W. Sams & Co., Inc., 1720 E. 38 St., Indianapolis 6, Ind.

COMPUTER HANDBOOK. Edited by H. D. Huskey and G. A. Korn, professors of electrical engineering, this handbook is intended as a reference covering the design of analog and digital computers and systems and their application to science and engineering. Technical information is presented in the handbook in sufficient detail to be useful in actual design work, and circuit diagrams give examples of design principles. There are also specific sections dealing with computer system design. The analog-computer sections present modern design practice in that field, including general-purpose analog computers and representative special-purpose machines. A review of analog-computer applications and methodology is included, as are a number of special computer setups and trick circuits, a chapter on solid-state components, and some of the less familiar analog techniques. The digital section begins with elementary definitions, component circuits, and computing circuits, and discusses logical techniques, design of arithmetic units, programming, and digital computer system design. Typical systems are described, and there is a chapter on applications. The 1,228-page book is available from McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., for $25.00.

INDUSTRIAL ELECTRONICS MEASUREMENT & CONTROL, by Edward Bukstein, describes the most common techniques presently employed in the field of industrial measurement and control. The first of two parts covers measurement techniques. Individual chapters are devoted to specific methods of measurement of pressure, illumination and color, temperature, humidity, moisture, liquid level, counting, time and speed, frequency, dimensions, and rate of flow. The second part, on control techniques, describes control of time delay, temperature, welding current, positioning, illumination, and controls. Components, circuits, and applications are described and explained in sufficient detail that the reader may learn how to service and maintain industrial electronic apparatus. The book is 192 pages long, and is priced at $3.95 from Howard W. Sams & Co., Inc., 1720 E. 38 St., Indianapolis 6, Ind.

DETECTOR & RECTIFIER CIRCUITS, Vol. 3 of the "Basic Electronics Series," written by Thomas M. Adams, explains detector and rectifier circuit operation, with circuit diagrams in color. Eight chapters include: Introduction to Rectification and Detection; Half-Wave Rectifier Circuits; Full-Wave Rectifier Circuits; Diode and Detector Circuits; Diode and Detector with Automatic Volume Control; Grid-Leak Detector Circuits; Discriminator Circuits; and Ratio Detector Circuits. The 128-page illustrated book is priced at $2.95 from Howard W. Sams & Co., Inc., 1720 E. 38 St., Indianapolis 6, Ind.

TUBE SUBSTITUTION HANDBOOK, Vol. 3, edited by the publisher's engineering staff, lists 5,234 recommended direct receiving tube substitutes. The directory of receiving tubes presents 1,687 types, with more than 2,750 substitutions. Three more sections list 224 industrial and 602 European substitutes for American receiving tubes; and 573 American receiving-tube substitutions for European types. The picture-tube section shows 465 types, with recommendations for 1,136 direct substitutions. Accompanying each section are instructions for making proper tube substitutions. Priced at $1.50, the book is available from How-

ard W. Sams & Co., Inc., 1720 E. 38 St., Indianapolis 6, Ind.

EVAPORATIVE COOLING OF CIRCULATING WATERS, by L. D. Berman, is a translation of a Soviet work. In this book the theoretical principles and methods of evaporative cooling of water in ponds, spray tanks, and coolers are discussed. The first part of the book deals with the problems of heat transfer and mass transfer during evaporative cooling, the theory of coolers, and some of the problems of the hydraulics of coolers; the second part describes the design of coolers for circulating water, methods of calculating their cooling capacity, and the main principles of their use. The 400-page book contains appendixes and a bibliography, and is priced at $20.00 from Pergamon Press, Inc., 122 E. 55 St., New York 22, N. Y.

BALL LIGHTNING. This is a collection of seven Soviet scientific papers in English translation. The papers deal with various aspects of Soviet research on ball lightning, including controlled reproduction and practical applications, which may be useful in the production of thermonuclear power. The 70-page book, priced at $12.50, is available from Consultants Bureau Enterprises, Inc., 227 W. 17 St., New York 11, N. Y.

1960 ASTM PROCEEDINGS, Vol. 60, the official record of the proceedings of the American Society for Testing and Materials, records the technical accomplishments, including reports, papers, and discussions which were offered to the Society during 1960 and accepted for publication in the *Proceedings*. The summary of proceedings of the 1960 annual meetings and the Annual Report of the board of directors are also included; 77 reports of technical committees, with supplementary appendixes, and 44 technical papers discuss subjects pertaining to research and standards for materials. Also included are lists of all symposia and other special sessions published separately, all papers published in ASTM monthly bulletin, summaries of symposia held by technical committees, and a subject and author index to all papers published by the Society in 1960. Copies may be obtained from the American Society for Testing and Materials, 1916 Race St., Philadelphia 3, Pa., for $12.00.

ASTM STANDARDS ON PLASTICS. Tests and specifications relating to cellular plastics, plastic pipe, and such materials as epoxies, urethanes, plastisols and organisols, and a test for measuring the tensile strength of plastics under impact conditions, are among the 25 new standards in the 12th edition of this compilation of standards. In addition to the 204 standard specifications, methods of test, and recommended practices included in the book, there are appended committee regulations and policies on use of the metric system and on writing specifications for plastics. Copies may be obtained from the American Society for Testing and Materials, 1916 Race St., Philadelphia 3, Pa., at $10.00 each.

IEC PUBLICATIONS. Three new publications have been issued by the International Electrotechnical Commission. Publication 135, *Numbering of Electrodes and Designation of Units in Electronic Tubes and Valves*, (9 pages, Sw. Fr. 3), applies to multielectrode tubes and valves, with the exception of cathode-ray tubes. It describes the system used for numbering the electrodes of the same type in multielectrode tubes and valves and for assigning designations to the units of multiple-unit tubes and valves. Publication 64, *Tungsten Filament Lamps for General Service*, (47 pages, Sw. Fr. 15), gives the technical requirements for lamps of 25- to 1,500-watt rating, 100 to 250 volts, with a nominal life of 1,000 hours. It also describes the methods of test for determining the quality and interchangeability of the lamps and their safety in use. Publication 134, *Rating Systems for Electronic Tubes and Valves and Analogous Semiconductor Devices*, (9 pages, Sw. Fr. 3), describes rating systems in use for electronic tubes and valves and analogous semiconductor devices. Its object is to bring about a greater understanding of these systems, especially in the division of responsibility between the manufacturer and the circuit designer. The publications are printed in French and English, and can be ordered from Bureau Central de la Commission Electrotechnique Internationale, 1, rue de Varembe, Geneva, Switzerland.

ASHRAE GUIDE AND DATA BOOK. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers has published its 1961 *Guide and Data Book*, which combines the *Heating, Ventilating, and Air-Conditioning Guide*, published since 1922, and the *Air-Conditioning and Refrigerating Data Book*, published since 1932. This volume features 880 pages of reference material on fundamentals and equipment. The second volume, on applications, will appear in 1962. The 1961 volume contains sections on theory, material, load calculations, system components, unitary refrigeration equipment, air-conditioning units, and refrigerant systems. The publication also includes an index for the 67 chapters, charts, graphs, and tables, and 406 pages of product specifications. Priced at $12.50, the book is available from ASHRAE, 345 E. 47 St., New York 17, N. Y.

EIA STANDARDS. Eight new technical standards have been prepared and published by the Electronic Industries Associations: *RS-241, EIA-NEMA Standards on Outlines for Semiconductor Devices*, 25 cents, defines the dimensional parameters of diode outlines DO-1 and DO-5. This standard will probably be supplemented with additional diode and transistor outlines as they become standardized; *RS-242, Definitions for Electromagnetic Delay Lines*, 40 cents, covers definitions for electromagnetic delay lines used in pulse circuitry, and includes definitions covering distortion, impedance, temperature coefficient, tilt, and time; *RS-243, Color Coding for Stereo Pick-up Leads*, 25 cents, covers the process of the title to include 3-, 4-, and 5-wire pickups; *RS-244, Character Codes for Numerical Machine Price Tool Control Perforated Tape*, 50 cents, is intended to serve as a guide in the co-ordination of equipment design, to minimize the number of sizes and codes of perforated tape used, and to minimize the variety of perforated tape preparation equipment required by users of numerically controlled machine tools. *RS-245, EIA-NEMA Standards on Letter Symbols and Abbreviations for Semiconductor Data Sheets and Specifications*, 80 cents, covers letter symbols and abbreviations for semiconductor data sheets and specifications, and includes 146 symbols and abbreviations, as well as the criteria and conventions associated with each. *RS-246, EIA-NEMA Standards for Environmental Method of Life Testing Lead Mounted Semiconductor Power Rectifiers*, 25 cents, covers this test method and specifies the minimum and maximum length between the mounting and the rectifier body. *RS-206-A, Recommended Practice for Preparation of Basing or Terminal Diagrams*, 60 cents, is intended as a guide in the formulation of basing and terminal diagrams for electron tubes, and includes the use of terminal and base pin symbols, numbering, and drafting practices associated with basing diagrams. The standard also includes a number of diagrams illustrating these rules. *RS-217-A, Wound Cut Cores*, 70 cents, a revision of *EIA Standard RS-217*, supplements the previously standardized dimensions for 400-cycle cores with dimensions for 60-cycle cores. These standards are available from the EIA Engineering Dept., 11 W. 42 St., New York 36, N. Y.

OTS REPORTS. The following publications have been made available to the public by the Office of Technical Services. *TID-12711, Possible Requirements for Radioisotopes as Power Sources*, 13 pages, 50 cents, gives the current status of possible large-scale uses of separated fission products and certain alpha-emitting isotopes in quantities which exceed present availability and market; *AD-255 294, Direct Energy Conversion Literature Abstracts*, 121 pages, $2.75, comprises a total of 548 abstracts on thermionic emission, photoelectric processes, magnetohydrodynamics, electrochemical processes, energy storage, and energy sources; *PB 161 612, Data Reduction Instrumentation for Radio Propagation Research*, 32 pages, $1, by W. E. Johnson, describes the equipment used by the Radio Propagation Engineering Division of the NBS for data-taking in connection with tropospheric radio propagation research; *TID-3562, Cobalt in Biological Metabolism*, 97 pages, $2.50, is a bibliography listing 972 references on the subject of metabolism and the mechanism of cobalt uptake by plants and animals, humans, and soils and water. *TID-7614, Uranium Carbides and Reactor Fuel Materials*, 153 pages, $1.50, is a report of the proceedings of a symposium on this subject, and covers preparation of this material, applications, and a status report. These publications may be ordered from the OTS, Washington 25, D. C.

RUSSIAN TRANSLATIONS

GENERAL INFORMATION

The publication of the translated Tables of Contents and reviews of articles from the translated issues of *Radio Engineering, Radio Engineering and Electronic Physics,* and *Telecommunications* is continued in this issue of *Electrical Engineering.* The translated issues of the three Russian journals are published by the AIEE with the co-operation of Royer and Roger, Inc. Normal publication of translations will take place 18 weeks after the appearance of the original text.

Page 36A of the September issue of *Electrical Engineering* gives a full description of subscription rates and special reduced rates for individual subscribers as well as a tear-out return postcard. Further information and subscriptions may be obtained from: AIEE, Special Subscription Department, 41 East 28th Street, New York 16, N. Y.

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3. *Trunova, N. V.,* Some methods for controlling the dispersion and coupling impedance of ribbed rectangular waveguides
4. *Kuznetsov, V. D., Paramonov, V. K.,* Device for investigating the directional properties of antennas
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5. *Segal', S. G.,* Transmission of radio signals through resonant systems with periodically varying parameters
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7. *Naumov, P. A., Yemel'yanov, G. A.,* Automation of operating controls in telegraph communications
8. *Shlyapoberskiy, V. I.,* On a multichannel system of telegraph communications
9. *Zubchenko, N. G.,* Comparative evaluation of receiver noise rejection for fluctuating noise in signals with frequency and single-band modulation

REVIEW OF TRANSLATED ARTICLES

The following reviews cover articles in the March 1961 issue of *Radio Engineering;* the January 1961 issue of *Radio Engineering and Electronic Physics;* and the February 1961 issue of *Telecommunications.*

Radio Engineering vol. 16, no. 3 March 1961

Analysis of a transistorized cascode resonance amplifier. *Kryukov, Yu. G., Simonov, Yu. L.*

Basic expressions are derived for a transistor pair having a first transistor in common emitter configuration with its collector directly connected to a second transistor connected in common base configuration, the combination having a tuned input and a tuned output. This cascode configuration is said to be especially adapted to wide-band amplification with automatic gain control. Expressions are derived for voltage gain and input and output admittances and it is shown that the voltage gain is practically the same as for a single transistor stage but since the inverse transfer admittance is much smaller, neutralization of the cascode circuit is unnecessary and higher stable gain is possible.

This article, submitted in November

1959, provides rather complete but laborious analytical confirmation of the parameters of a transistor amplifier then in wide use but more often in a form embodying reverse feedback via a resistor shunting the basic-collector circuit of the first transistor.—J. R. Hyneman

Distribution of residual magnetism across the thickness of the tape carrier of magnetic recording. *Geranin, V. A.*

The process of magnetic tape recording does not magnetize the magnetic coating uniformly throughout its thickness, but in a complex pattern which is a function of recording frequency and tape speed. Direct measurement of the variation in intensity of magnetization throughout the coating presents very considerable problems. This paper describes a method of deducing the distribution of magnetic intensity from a comparison of signals reproduced from opposite sides of the magnetic layer.

Other work (Wallace, 1951) indicates the likelihood of substantial difficulties in making reliable measurements on the underside of the magnetic layer. If these measurements can be made reliably, and if the underlying mathematical treatment is sound, the paper represents an advance in analyzing the behavior of thin magnetic films. The paper is not believed, however, to be of general interest beyond this area.—H. T. Head

Ideal signal enhancement with diversity reception of discrete information. *Klovskiy, D. D.*

The paper deals with the question of diversity reception of binary-type signals in the presence of fluctuation noise and fading. As such, it is an extension of previous work by Klovskiy, utilizing the same basic concepts and mathematical approach. In this, the signal is considered to be steady state, reception is in the presence of fluctuation noise, and the medium is expressed in terms of the distribution of transmission coefficient and phase shift. A Rayleigh-type distribution is assumed.

In the present case the effect of a number of independent diversity branches is considered with both coherent and noncoherent reception. The treatment is applicable to the four types of diversity possible—time, frequency, space, and polarization.

The derivation aims at establishing the error probability as a function of signal-to-noise energy ratio, in terms of the distribution of the transmission coefficients. This distribution is expressed mathematically so that the behavior extends from the case of a nonvarying medium to one properly identified by a Rayleigh distribution. It is shown that diversity improvement is then a maximum for the latter condition. Curves are provided illustrating the application of the basic error equations to a dual (space) diversity system.

As a new mathematical model, this has some novelty. However, the matter of diversity operation has now been treated rather thoroughly in our own literature by such authors as Watt, Montgomery, Altman, Turin, and Pierce. In this respect the present treatment offers nothing new, and in fact, lacks the utility developed by our writers. Of particular interest is the treatment by Pierce and Stein, published some months before the receipt of the present paper for publication (July 1960), of the much more difficult and sophisticated case, namely, multiple diversity behavior as a function of the correlation coefficient.

One would assume on this basis that our work in sophisticated diversity receivers and receiving techniques would be substantially ahead of our Russian counterparts. One might further postulate that we are significantly further ahead in the utilization of tropo scatter for long-haul communication, since this is so intensely tied up with diversity operation.—C. A. Barry

Radio Engineering and Electronic Physics vol. 6, no. 1 January 1961

Cross correlations of field fluctuations of receiving lenses with finite dimensions. *Bakhareva, M. F.*

This report derives the cross correlation coefficient for field fluctuations at the focuses of lenses when an incident monochromatic, initially plane wave passes through a medium with extensive random discontinuities in its refractive index. It is shown that when the dimensions of the lens are commensurate with the radius of cross correlation of field fluctuations, the increase in the distance between receiving points and coefficient decreases more slowly in the presence of lenses than in the absence of lenses. This paper presents in abbreviated form the cross correlation of field fluctuations for the case of lenses in a plane perpendicular to the direction of propagation. The author presents the specific problem in a clear, concise manner and calculates the results with a minimum of redundancy and in a form suitable for application. The resultant formulations are illustrated graphically for particular cases of lens spacing and sizes.—J. H. Vogelman

Calculation of cross noise power in long-distance scatter communication system. *Prosin, A. V.*

The author calculates the intermodulation noise (cross noise) in a frequency multiplex tropospheric scatter system due to the presence of multipath signals. The calculation is based on a path model for the tropospheric scatter mechanism involving a Gaussian distribution of the dielectric constant about some mean value, but including a constant signal at the receiver due to diffraction, superrefraction, or other mechanisms (although expressions are offered for intermodulation noise in the absence of this constant component). This model proves to be intractable mathematically and it requires some simplification by the author. The model further assumes a knowledge of the change of scatter coefficient and decrease in fluctuation intensity with height of the common scatter volume and also the variation of scatter bandwidth with antenna directivity. A restraint is imposed requiring small relative delay of the constant signal and the scattered signals, and further assumes that the envelope of the scatter signal time correlation falls slowly with time.

The author finds the frequency multiplex channel having the largest amount of intermodulation noise (the highest channel), and that the intermodulation noise power is inversely proportional to the fourth power of the tropospheric bandwidth. He calculates an optimum antenna-pointing doctrine and beamwidth to minimize noise over given path lengths, and that the presence of a steady signal substantially decreases cross-noise power.

No experimental data are offered to verify the theoretical predictions or to support the path model. All prior references written by the author must be at hand for reading this paper because the notation is not defined except by reference to earlier papers; six of the eight references are to the author's own works. No references are made to American or other foreign works of a closely allied nature such as the theoretical work of S. O. Rice, "Statistical Properties of Sine Wave plus Random Noise," *Bell System Technical Journal*, January 1948; the analytical and experimental work of Albershein and Schafter, "Echo Distortion in FM Transmission of Frequency Division Multiplex", *Proceedings*, Institute of Radio Engineers, March 1952; H. Bremmer's, "On the Theory of Fading Properties of a Fluctuating Signal Imposed on a Constant Signal," NRS Circular No. 599, May 1959; and the references given in these papers. On the other hand, the non-Russian authors do not consider the implication of such explicit models of the scattering mechanisms of intermodulation noise as does Prosin. In this sense Prosin's work is unique.

To the extent that one accepts the author's choice of the particular model for scattering and subject to the availability of adequate experimental data to support his model, the paper should be studied further by those concerned with minimizing intermodulation noise due to multipath in tropospheric scatter applications of frequency division multiplex. —H. Sherman

Some theoretical problems in the operation of a microwave phasemeter. *Rubin, S. B.*

This paper is a careful and detailed study of the operational accuracy of a

serrodyne microwave phasemeter. Formulas are given for the phase error due to such things as mismatch, crystal mixer characteristics, traveling-wave tube characteristics, klystron instability, and nonideal amplitude limiters. In addition to the more obvious conclusions, the author emphasizes the importance of constant detector admittance, image-frequency rejection, and multiple-amplitude limiters.

This paper contains more detail on the many aspects of serrodyne phasemeter accuracy than is usually available from one source. As such, it should be of great value to anyone contemplating the design of such a system. For one whose interest in the subject is more casual, the brevity of its general discussion, and its lack of any summary of the relative importance of the various sources of error, reduce its value.—G. R. Cooper

Diffraction of a plane electromagnetic wave propagating along the axis of a cone. *Goryainov, A. S.*

This paper considers the diffraction field which results when a plane electromagnetic wave impinges on an infinite conducting cone. The axis of the cone is parallel to the direction of propagation. The exact solution is found in series form, as well as the narrow-cone angle and the wide-cone angle approximations. The exact solution is then considered as the sum of a field defined from the laws of physical optics and a correction field caused by currents near the surface and apex of the cone.

Most of the analysis is straightforward. The original series contains the usual defects of diffraction problem solutions such as slow convergence. The authors have generated a new series which avoids some of these difficulties. The work is very detailed, and curves are given. Over all, the study of this specific problem is quite complete.—B. Harris

Thermal fluctuations in nonlinear systems. *Bunkin, F. V.*

This paper relates to the relationship of fluctuations (noise) in a nonlinear system and its dissipation (resistance) characteristics. After a brief review of some of the previous works dealing with thermodynamic equilibrium fluctuations in nonlinear systems, the author points out that the assumptions on which the fluctuation-dissipation theorem are based do not restrict the macroscopic properties of a system to linearity. A discussion is then given of application to nonlinear resistance elements.

The paper is presented primarily from the point of view of the physicist and assumes thorough familiarity of the reader with the reference material. For example, the fundamental equations are taken directly from one of the references. The article is recommended only for specialists in fluctuation theory. It is hoped, however, that one of these might subsequently present the implications of this work as they affect the practicing engineer.—T. T. N. Bucher

Power spectrum of a signal obtained by scanning. *Ignat'yev, N. K.*

A very general description is given of the power spectrum of the signal which results from scanning a multidimensional object. The well-known result that scanning leads to definite regularities in the structure of the spectrum is discussed. The purpose of this paper is apparently the unification of results previously obtained by others. However, the formulation here is so general that specific papers in the literature devoted to the properties of television scanning, radar scanning, and the like are of much more value. Not only are basic articles omitted from the references, such as that of Mertz and Gray in "A Theory of Scanning and Its Relation to the Characteristic of the Transmitted Signal in Telegraphy and Television" (*Bell System Technical Journal*, vol. 13, July 1934, pp. 464-515), but the author references only himself. A study of the literature would have shown that the results obtained are not new.—B. Harris

Incidence of a plane electromagnetic wave on a plane grid (case in which the H vector is parallel to the wires). *Sivov, A. N.*

The reflection and transmission coefficients are found for a plane wave striking a plane grid at an angle, when the *H* vector is parallel to the grid wires. The grid spacing is assumed small compared to the wavelength, and the dielectric is different on each side of the grid. Expressions are found for the far and near fields. Wires are considered with both round and rectangular cross sections.

These specific problems are examined in detail. The analysis is straightforward. The major defect of the paper is that no curves are given.—B. Harris

Telecommunications vol. 15, no. 3 March 1961

Incidence of a plane wave on a selective reflecting surface. *Talyziu, N. V.*

This paper discusses the calculation of the reflection and transmission coefficients of a 2-dimensional array of dipoles, coupled only by the incident, plane, electromagnetic wave. The reflection coefficient of such an array is referred to that of a metallic sheet. Curves of radiation resistance and reactance are shown, as are curves of the values of dipole diameter, length, and spacing for total reflection. Experimental checks are shown.

Most, if not all, of this material is treated in Kings' book *The Theory of Linear Antennas*, Harvard University Press, 1955.—W. A. Miller

Noise-proof feature of telegraph communication along the telephone channel of a tropospheric link. *Gerenrot, Ye. L.*

Expressions are developed for the probability of noise interference on telegraph circuits routed over a tropospheric radio system, with single, dual, or multiple receiver operation, under rapid-fading conditions, for a single section of radio and for several tandem radio sections.

The expressions make it possible to evaluate the effect on telegraph noise of changing receiver parameters and of using dual or multiple receivers in lieu of a single receiver.

A mathematical analysis of the probability of noise interference is presented, assuming a tropospheric system (with frequency division multiplying and frequency modulation with the use of single and separated receivers with automatic selection).—F. G. Hollins

Contactless units for trunk line with multiplex KRR-30/60. *Bosenko, V. G., Maksimov, G. Z.*

This article describes compact, contactless cable and radio equipment now in production. It is used for the multiplexing of trunk lines between local automatic exchange offices. Each set of equipment consists of an incoming and an outgoing unit installed at the respective ends of the channel. The size of the unit is three to four times less than that of an all-relay system but the cost is approximately the same. Operational tests of an experimental model at the Stalingrad Central Office in 1958 showed positive results and high reliability of the semiconductor equipment.

Channel inputs are isolated from dialing pulses during dialing. The called subscriber must answer before the channel is excited. The unit transmits all signals in the case of ring-off with an incomplete connection. Transmission of the "busy" signal to the calling subscriber is insured in the event that the chosen channel is inoperative. Appropriate warning-signal connections are also made. All triggers in the unit are switched only through separate inputs. All switching in the units is static by means of directional and switching diodes.

This is another example of the successful trial and application of semiconductors to conventional communication equipment. Group selectors, line finders and commutators with wipers are used in the associated equipment. Advantage is not taken of the statistical time-frequency structure of speech and trunk information capacity. Other all-electronic systems which use semiconductors extensively are more efficient in this regard.—G. B. Worthen

AIEE ON THE MOVE

Technical committees to organize 118 sessions for Winter General Meeting

The AIEE Winter General Meeting will be held January 28-February 2 in New York City. Technical sessions will be held at the Statler Hilton and the Governor Clinton Hotels, as well as at the Coliseum, the site of the Electrical Engineering Exhibition. About 118 sessions are to be organized by technical committees in each of the Institute's six technical divisions. More than 600 Transactions and Conference papers are expected to be programmed for this meeting.

INFORMAL TEA

The informal tea before the formal program begins has been enjoyed by more and more persons each year. This year, this social gathering will be held on Sunday, January 28, at 4:00 p.m., in the ballroom of the Statler Hilton Hotel. There will be no charge.

From 2:00 p.m., the registration facilities will be open for those who wish to avoid the Monday morning rush.

HOTEL RESERVATIONS

Blocks of rooms have been set aside at both the Statler Hilton and Governor Clinton Hotels, for members and guests attending the meeting. Letters of request for reservations should be sent to the hotel selected, specifically referring to the AIEE meeting. Those attending are requested not to write to more than one hotel. If a request cannot be filled, it will be automatically referred by the hotel to the Hotel Accommodations Committee whose duty it is to obtain a similar reservation at a nearby hotel. The hotel will confirm directly to each applicant.

Because of the crowded conditions in New York hotels, it is suggested that your reservation be made for arrival on Sunday, January 28, thereby avoiding delays in registration or unavailability of rooms in the early morning of subsequent days.

Rooms have been allotted for our use by the following hotels at the daily rates indicated:

Statler Hilton Hotel (meeting headquarters) 7th Ave., 32nd to 33rd Sts.
Single room ..... $ 8 to $15.50
Double room ..... $11 to $18.50
Twin bedroom ..... $15 to $25.00

Hotel Governor Clinton (also used for meetings) 7th Ave., 31st St.
Single room ..... $ 8 to $14
Double room ..... $10 to $16
Twin bedroom ..... $12 to $18

All rooms have private bath and the rates quoted are subject to a 5 per cent New York City hotel room tax.

SMOKER

One of the social highlights of the Winter General Meeting will be the Smoker on Tuesday evening, January 30, in the Grand Ballroom of the Hotel Statler Hilton. Here will be found good food, good fellowship, and top quality entertainment.

Requests for tickets should be sent in at an early date. The price of the ticket will be $11.50, and requests should be addressed to the "AIEE Smoker Committee" at 345 E. 47 St., New York 17, N.Y., and accompanied by checks made payable to "Special Account, Secretary, AIEE."

DINNER-DANCE

The Dinner-Dance will be held Thursday evening, February 1, in the Hotel Statler Hilton. Dress will be formal. Write soon for reservations for tables for 10. The price this year is $14 per ticket and requests should be sent to "AIEE Dinner-Dance Committee" at 345 E. 47 St., New York 17, N.Y., accompanied by checks made payable to "Special Account, Secretary, AIEE."

INSPECTION TRIPS

A program of inspection trips is presently being prepared which will include many of the more popular trips scheduled in previous years as well as others that have not been available previously. Included in the schedule are trips to: Bell Telephone Laboratories, Brookhaven National Laboratories, Consolidated Edison Company's Astoria Generating Station, Federal Pacific Electric Company, General Motors Linden Plant, General Post Office in New York City, Holophane Light and Vision Institute, International Business Machines Corporation, James Forestal Research Center, New York Stock Exchange, New York Times, Radio City Music Hall, and United Nations General Assembly.

Also scheduled are trips to a cable company, color television studio, a steamship, and the new United Engineering Center.

LADIES ENTERTAINMENT

Plans are being made by the Ladies Entertainment Committee for an interesting week of events for the ladies attending the Winter General Meeting.

There will be a Coffee Hour each morning, Monday through Friday. A Tea has been arranged for Monday afternoon. On Tuesday, there will be a tour through Helena Rubinstein's Town House. This will be followed by a dinner with entertainment at the Penn Top of the Hotel Statler Hilton. A tour of the United Nations is scheduled for Wednesday. There will be a luncheon and fashion show at the Waldorf Astoria Hotel on Thursday.

WINTER GENERAL MEETING COMMITTEE

Members of the 1962 Winter General Meeting Committee are: R. W. Gillette, chairman; W. G. Vieth, vice-chairman; J. J. Anderson, secretary; R. T. Weil, Jr., AIEE vice-president for District 3 and budget co-ordinator; D. E. Trucksess, representative, Technical Operations Department; J. J. O'Connor, chairman, Public Relations Committee; J. C. Hoyt, General Session; R. E. Briesemeister, hotel accommodations; F. C. Reed, Jr., registration; W. McConnachie, inspection trips; T. W. Bartlett, monitors; J. G. Derse, smoker; J. E. Bevan, dinner-dance, and Mrs. R. W. Gillette, ladies events.

Four societies meet jointly

"Advances in Electrical Power Generation" was the subject of the AIEE Cleveland Section's October meeting held jointly with the American Society of Mechanical Engineers (ASME), Institute of Radio Engineers (IRE), and Instrument Society of America (ISA). Present at the meeting were: (left to right) *F. W. Kirk, ISA Cleveland Section chairman; L. J. Shaffer, AIEE Cleveland Section chairman; O. G. Hanson, Consolidated Edison Company of New York, guest speaker; D. Albanese, program chairman, ASME, and J. Hall, ASME Cleveland Section chairman. Absent from the photograph is R. Kazarin, IRE Cleveland Section chairman*

Calendar of Future Meetings

TP—Transactions Paper
CP Syn.—Conference Paper Synopsis
CPMs—Conference Paper Manuscript
DPMs—District Paper Manuscript*

Notice to Authors Strict compliance with the "Author's Guide" will save you time, delays, and unnecessary correspondence. For a copy, write to E. C. Day, 345 East 47 Street, New York 17, N. Y.

December 10-14, 1961
AIEE-IRE-ACM
Eastern Joint Computer Conference†
Sheraton-Park Hotel
Washington, D. C.

January 9-11, 1962
AIEE-IRE-ASQC-EIA National Symposium on Reliability and Quality Control†
Statler Hilton Hotel
Washington, D. C.

January 28-February 2, 1962
Winter General Meeting†
Hotel Statler Hilton
New York, N. Y.

February 15-16, 1962
AIEE-IRE-U of Pa. International Solid-State Circuits Conference
University of Pennsylvania and
Sheraton Hotel
Philadelphia, Pa.
(Final date for TP—closed, CP Syn.—Dec. 8, CPMs—Dec. 19)

February 19-22, 1962
AIEE-NEMA
Electrical Insulation Conference
Shoreham Hotel
Washington, D. C.
(Final date for TP—closed, CP Syn.—Dec. 6, CPMs—Dec. 15)

March 1-2, 1962
AIEE-IRE-AEC-NBS 8th Scintillation and Semi-Counter Conference
Shoreham Hotel
Washington, D. C.
(Final date for TP—Dec. 1, CP Syn.—Dec. 15, CPMs—Dec. 26)

March 14-16, 1962
EHV Communication, Control, and Relaying Conference
Baker Hotel
Dallas, Tex.
(Final date for TP—Dec. 14, CP Syn.—Dec. 29, CPMs—Jan. 8)

March 27-29, 1962
AIEE-IIT American Power Conference
Sherman Hotel
Chicago, Ill.
(Final date for TP—Dec. 27, CP Syn.—Jan. 11, CPMs—Jan. 22)

April 3-5, 1962
Cement Industry Conference
Chase Hotel
St. Louis, Mo.
(Final date for TP—Jan. 3, CP Syn.—Jan. 18, CPMs—Jan. 29)

April 4-6, 1962
South Central District Meeting
Hotel Peabody
Memphis, Tenn.
(Final date for TP—Jan. 4, DPMs—Jan. 29)

April 9-10, 1962
Rubber and Plastic Industries Conference
Sheraton Hotel
Akron, Ohio
(Final date for TP—Jan. 9, CP Syn.—Jan. 24, CPMs—Feb. 2)

April 10-11, 1962
AIEE-ASME-EIC Railroad Conference
King Edward Hotel
Toronto, Ont., Canada
(Final date for TP—Jan. 10, CP Syn.—Jan. 25, CPMs—Feb. 5)

April 17-19, 1962
Rural Electrification Conference
Fort Shelby Hotel
Detroit, Mich.
(Final date for TP—Jan. 24, CP Syn.—Feb. 1, CPMs—Feb. 12)

April 18-20, 1962
Great Lakes District Meeting
Hotel Van Orman
Fort Wayne, Ind.
(Final date for TP—Jan. 18, DPMs—Feb. 9)

April 30-May 2, 1962
Mid-America District Meeting
Hotel Chase
St. Louis, Mo.
(Final date for TP—Jan. 30, DPMs—Feb. 23)

May 1-3, 1962
WJCC Spring Joint Computer Conference
Fairmont Hotel
San Francisco, Calif.
(Final date for TP—Jan. 31, CP Syn.—Feb. 15, CPMs—Feb. 26)

May 7-9, 1962
Middle Eastern District Meeting
Hotel DuPont
Wilmington, Del.
(Final date for TP—Feb. 6, DPMs—Mar. 2)

May 8-10, 1962
AIEE-IRE Joint Electronic Components Conference
Marriott Twin Bridges Motor Motel
Washington, D. C.
(Final date for TP—Feb. 7, CP Syn.—Feb. 22, CPMs—Mar. 5)

May 9-11, 1962
North Eastern District Meeting
Hotel Statler Hilton
Boston, Mass.
(Final date for TP—Feb. 8, DPMs—Mar. 5)

May 14-16, 1962
Joint District Meeting
Erie, Pa.
(Final date for TP—Feb. 13, DPMs—Mar. 9)

May 22-23, 1962
Appliance Technical Conference
Deshler Hilton Hotel
Columbus, Ohio
(Final date for TP—Feb. 22, CP Syn.—Mar. 9, CPMs—Mar. 19)

May 23-25, 1962
AIEE-ISA-ARS-IAS
National Telemetering Conference
Sheraton-Park Hotel
Washington, D. C.
(Final date for TP—Feb. 22, CP Syn.—Mar. 9, CPMs—Mar. 19)

June 4-7, 1962
EJC Nuclear Congress and Atomic Exposition
New York Coliseum
New York, N. Y.

June 17-22, 1962
Summer General Meeting
Hotel Denver Hilton
Denver, Colo.
(Final date for TP—Mar. 19, CPMs—April 11)

June 27-29, 1962
AIEE-AIChE-IRE-ISA-ASME
Joint Automatic Control Conference
New York University
New York, N. Y.

August 13-16, 1962
Pacific Energy Conversion Conference
Fairmont Hotel
San Francisco, Calif.
(Final date for TP—May 14, CP Syn.—May 29, CPMs—June 8)

August 27-September 1, 1962
IFIPS Congress
Munich, Germany

* District Paper Synopses should be directed to the District Meeting Committee
† Final date for submitting papers—closed

New products to be introduced at AIEE Electrical Engineering Exposition

Many new, exciting, and challenging products and services will be unveiled for the first time at the nation's first Electrical Engineering Exposition that will be held January 29-February 2, 1962, in the New York Coliseum.

Among these new products, according to a survey of the first 65 firms assigned space in the Exposition, are:

A highly automated electronic microscanning device capable of peering into every inch of an insulated cable to detect flaws.

A porous alumina for 3,000 F operation and with an arc resistance of 900 seconds against 150,000 volts.

Metalized glass bonded mica for use as memory boards, printed circuits, capacitance switching, commutators for telemetering.

A microminiature incandescent lamp, smaller and lower in power than any now available.

A pad-mounted transformer for use with underground residential distribution.

An easy-to-machine mica-bonded synthetic mica for 1,800 F operation which can be fused into a pure white insulator.

A high-temperature bushing made of a wet process porcelain body to which the stainless steel nonmagnetic hardware has been bonded at more than 300 F and from which it cannot be forcibly removed.

The Electrical Engineering Exposition, the first industry-wide event of its kind, will be held in conjunction with the Winter General Meeting of the AIEE. More than 5,000 engineers from every segment of the electrical-electronics industry are expected to attend the 5-day technical conference and view the panorama of nearly 200 product and service exhibits.

A survey to determine whether firms exhibiting at the Exposition were planning to unveil any new products or services at the event brought many "exciting replies," according to N. S. Hibshman, Executive Secretary of AIEE. "The answers we received," he said, "were to a large extent guarded. But they left no doubt in our minds that a large number of newly developed products and services will be introduced to the industry for the very first time at this Exposition."

The 1962 Electrical Engineering Exposition, unlike any other, has been conceived and designed to meet the special educational needs of the electrical-electronics industry. "It is an across-the-board exposition, custom-built to interest every engineer in every segment of the industry, and tailored to be an integral part of our technical conference," Mr. Hibshman said.

Many of the exhibits will be staffed by research engineers and design engineers responsible for the advancing technology in the electrical-electronics industry. These men will help keep the attending AIEE engineers abreast of the great range and swift pace of developments taking place in the electrical engineering field.

H. F. Grebe, exhibits manager of the Reber-Friel Company of Philadelphia, Pa., said a review of the exhibits shows that the Electrical Engineering Exposition will encompass all the products and services of the electrical-electronics industry.

The exhibits will present equipment and supplies for the nation's electrical utilities, for mining and refining, for steel, metals, ceramics, and general manufacturing. They will display materials and components for use in chemical construction, electric and electronics controls and communications, and in government applications.

Detailed information about the Electrical Engineering Exposition may be obtained from the Reber-Friel Company, 117 S. 17 St., Philadelphia 3, Pa.

Board actions at October meeting include move toward AIEE-IRE merger

The Board of Directors held its regular Fall meeting on Friday, October 20, the final day of the 1961 Fall General Meeting in Detroit, Mich. The usual agenda of essential but routine items was considered and acted upon in the course of the day's meeting. The item of possible historic significance was introduced by a specially invited guest, Dr. P. E. Haggerty, Jr., President-Elect of the Institute of Radio Engineers (IRE).

MOVE TOWARD MERGER APPROVED

Dr. Haggerty presented official notice that on October 18, 1961, the Board of Directors of IRE had unanimously approved a resolution calling for immediate and intensive exploration of the possibility of consolidating into one organization the AIEE and the IRE, and expressing the intent promptly to consummate the merger, if found feasible. The companion resolution, recorded on p. 909 of this issue, making the same declaration on behalf of AIEE, was moved, discussed, and approved by unanimous vote.

Discussion of the proposed consolidation brought out the view that many difficult problems would have to be solved in the creation of a single new organization embodying the best features of the present two Institutes and designed to serve all of the diverse aspects of the modern electrical engineering profession. How the planning for, and decisions on, these matters will be handled is discussed by AIEE President W. H. Chase beginning on p. 908 of this issue.

BYLAWS AMENDED

Three amendments to the Institute Bylaws were voted at this meeting:

1) Graduate Students were given one free subscription to the Bimonthlies by the amendment of the following bylaw which will now read:

"B40.016b1 Each member who is a Graduate Student as stipulated in B40.013e may subscribe to any one Bimonthly publication without charge. For subscriptions to additional Bimonthlies, the regular member prices will prevail."

2) The General Administration Department's control of the content of student publications was confirmed by the insertion of the following paragraph in B80.060dl:

"It (GAD) is responsible for controlling the content of publications for students."

3) The limit on the number of members of the Professional Conduct Committee was lifted by the amendment of the first sentence of B80.060f4 to read:

"The Professional Conduct Committee consists of seven *or more* members."

OFFICER-DEVELOPMENT PROGRAM

The Officer-Development Program, calling for the establishment of organizational machinery on an Institute-wide basis for the orderly creation of a pool of well-qualified candidates for all offices, and especially for the production and prenomination comparative evaluation of candidates for President and Director-at-Large, was not offered for action by the Planning and Co-ordination Committee, as requested by the Board of Directors last June, because of objections raised in committee by the General Administration Department, which is expected to offer an alternative plan.

FINANCES

The Treasurer reported a cash balance of $387,482.35 after expenditures of $1,044,714.47 for the first 4 months of the fiscal year. The pattern of financial developments appears to be following that of previous years in which the outcome was satisfactory. The Balance Sheet as of July 31, 1961, showed assets of $2,690,875.

The Chairman of the Finance Committee reported income and expenses for the first 3 months of the fiscal year and commented upon the unusually high percentage of dues payments received as compared with former years.

Authorization was voted for the publication of a 2-volume set of Power Cable Ampacity Tables as compiled by the Insulated Power Cable Engineers Association and the AIEE Insulated Conductors Committee.

United Engineering Center contributions totalling $915,000 were reported.

The Group Insurance Program was reported close to becoming operative (the first policies were actually issued November 1).

J. R. O'Hanlon, Secretary of the Potomac Electric Company, Washington, D.C., was appointed to be Trustee for the AIEE Group Insurance Program.

UNITY

While prospects of unity within the electrical engineering profession took an important step forward at this meeting, it also appeared that steady progress was being made on an interdisciplinary basis as well. The Board approved in principle, and authorized the President to sign after minor editorial changes, a declaration of intent on the part of the American Society of Mechanical Engineers, the National Society of Professional Engineers (NSPE), and AIEE to encourage coordination of intersociety affairs along functional lines and to support and advocate expansion and development of the Conference of Presidents of the Engineers for Professional Development, the Engineers Joint Council, and NSPE.

AIEE's observer at the Roanoke meeting of the NSPE Board, C. F. Savage, reported by telephone that the NSPE Board had approved and sent to the membership for vote a constitutional amendment creating a new grade of NSPE membership, "Engineer." This would be a voting but not office-holding grade open to nonregistered engineers holding Member grade or higher in one of the Founder Societies. The corollary question of eventually making registration a requirement of the Member grade was not considered by the AIEE Board.

NOMINATING COMMITTEE REPRESENTATIVES

To represent the Board of Directors on the Institute Nominating Committee, the following were elected: Walter Criley, J. W. Davis, E. A. Harder, W. A. Lewis, N. F. Rode, and P. G. Wallace. Alternates to be called upon in the order listed are the following: A. W. Rauth, Bradley Cozzens, C. T. Hatcher, and B. V. Martin.

UET APPOINTMENT

Dr. L. F. Hickernell was appointed to the Board of the United Engineering Trustees to fill the unexpired term of Past-President W. J. Barrett. Mr. Barrett resigned following his retirement from the New Jersey Bell Telephone Company and taking up residence in Tucson, Ariz. The term extends to October 1963.

EDISON MEDAL COMMITTEE REPLACEMENT

Hendley Blackmon was elected by vote of the Board to fill the place on the Edison Medal Committee vacated by the resignation of E. I. Green. The term is for 2 years beginning August 1, 1961.

FELLOWS ELECTED

G. K. Carter, R. F. Davis, G. P. Fallon, and R. T. Weil, Jr., were elected to the grade of Fellow. Biographical information and the citations associated with their election will appear in a subsequent issue of *Electrical Engineering*.

AIEE-IRE STUDENT CONFERENCE

The Board approved exception to the travel allowance regulations to permit Districts 1 and 12 to hold with the corresponding IRE Region a joint Student Conference on November 11.

ORGANIZATION AND POLICY STUDY

As a part of the agreed intention of IRE and AIEE to continue all activities and planning operations regardless of merger explorations, the Board voted to confirm appointments and scope of the Special Committee for Organization and Policy Study set up by AIEE President C. H. Linder with Board approval in his 1960-61 administration.

The scope of this special committee as approved is as follows:

"To restate and define the Institute's objectives in detail in the light of limitations and opportunities presented by its environment; to evaluate present policies and program in relation to these objectives; and to propose a set of policy statements in detail designed for testing programs and activities for their orientation with respect to these objectives of the Institute."

The members of the Special Committee are Dr. Ernst Weber, chairman; P. A. Abetti; Harold Chestnut; G. L. Hollander; M. D. Hooven; S. W. Herwald, and J. G. Trump.

RESOLUTIONS

Resolutions of commendation and congratulation were voted to be addressed to the 1961 Fall General Meeting Committee in appreciation for their services in the planning and management of an eminently successful meeting.

Resolutions of congratulation and appreciation were also addressed to the Michigan Section which celebrated its 50th anniversary during the 1961 Fall General Meeting.

FUTURE MEETINGS

The 1963 Pacific General Meeting at Spokane, Wash., on August 20-23 will conform to the usual general meeting pattern as regards its program and direction. This announcement by the Technical Operations Department was in response to questions raised by the experimental plan announced for the 1962 Pacific General Meeting at San Francisco which will utilize a format more nearly that of a Special Technical Conference.

The 1966 Summer General Meeting will be held in Dallas, Tex., in response to an invitation from District No. 15 and the North Texas Section.

The 1963 North East District Meeting at Portsmouth, N. H., dates have been altered: it will take place May 20, 21, and 22.

The 1965 and 1966 General Meeting dates are still unsettled as a result of a desire to conform to National Electronic Conference dates as yet unset.

FUTURE BOARD MEETINGS

The next scheduled meeting of the Board of Directors would be February 2, 1962, at the AIEE Winter General Meeting.

Institute prizes established to promote meritorious technical papers

To recognize and promote the contribution of meritorious papers, the AIEE has established a series of prizes which are available for annual award to members for outstanding papers. All awards are optional, not obligatory, and it is expected that discriminating judgment will be made by each responsible committee. Each prize consists of a sum of money and/or a Certificate of Award. Appropriate recognition will be given in *Electrical Engineering*.

Prizes are available on the national level, known as Institute prizes; on the District level; on the Section level; and on the Student Branch or Undergraduate level.

To be eligible for an award, a paper must have been presented at a qualified technical meeting of the AIEE (Winter, Summer, Fall, or Pacific General Meeting; District Meeting; Special Technical Conference; Section, Technical Group, or Subsection Meeting; or Branch Meeting), except as provided in Section (*b*) under Institute Prizes.

Any monetary prize will be divided between coauthors and each will receive a certificate. Certificates and checks for awards are prepared by the Professional Development and Recognition Department at Headquarters under the cognizance of the Prize Awards Committee. An equivalent gift may be substituted for the monetary prize.

To be eligible for any award, the author, or at least one coauthor, of a paper must be a member (any grade) of the Institute and the other coauthors must be members of a professional society of comparable standing. District, Section, and Branch prizes will be limited to papers, one of whose authors is resident or employed within the respective territory. AIEE committee and subcommittee reports are not eligible for prizes.

All prizes will be awarded on the basis of papers presented during the administrative year, nominally August 1 to July 31, except as specifically stated within these rules. The technical excellence of the paper and its value in its field should constitute the primary basis of awarding of prizes rather than the numerical grades assigned by the original reviewers.

Prizes based on competitive presentation may be withheld whenever, in the opinion of the responsible committee, the number of papers is not sufficient to constitute a real competition. Such papers may be included in competition with those that are presented in the following year.

INSTITUTE PRIZES

The awarding of the Institute prizes shall be the responsibility of the Prize Awards Committee, which is appointed annually by the Institute President in accordance with the Bylaws. The Institute prizes will

be presented at the regular Winter General Meeting.

The Institute or national prizes will consist of (*a*) one from each Division, (*b*) one for papers sponsored by general committees and articles in *Electrical Engineering*, and (*c*) a best student paper.

(a) Division Papers:

Only Transactions papers shall be eligible for Division prize awards. There shall be one first prize for each Division consisting of a certificate and $100. In special cases, additional certificates may be awarded at the discretion of the Prize Awards Committee. All Transactions papers will be considered for Division prizes without formal offering in competition. The awards will be presented at the regular Winter General Meeting.

The Division prizes shall be judged by the Prize Awards Committee upon recommendation of a Prize Awards Subcommittee of each of the Divisions.

As an aid to the Prize Awards Committee, a Prize Awards Subcommittee shall be appointed by each Division chairman at the beginning of the administrative year and shall consist of not less than three members of the Division. Recommendations for Division prizes for papers presented during the administrative year shall be submitted by the Subcommittee to the Prize Awards Committee not later than September 1 of the following administrative year.

To assist the Divisional Prize Awards Subcommittee, each Technical Committee Chairman is urged to submit nominations for the National Prizes to his Divisional Prize Awards Subcommittee, accompanied by a brief statement giving reasons why each paper is worthy of consideration.

(b) Papers Sponsored by General Committees and Articles in Electrical Engineering:

To encourage the authors of papers sponsored by general committees, and authors of articles in *Electrical Engineering*, an additional prize consisting of a certificate and $100 has been set up. All such papers will be considered for this award if submitted in triplicate to the Institute Secretary before July 31 of the administrative year and accompanied by a written statement as to why it is of prize caliber.

(c) Best Student Paper:

A Best Student Paper award also is included among the Institute awards. This consists of a certificate and $100. All student papers which have won a prize in Branch or District student competition will be considered for an Institute award if submitted in triplicate to the Institute Secretary before July 1 of the administrative year in which presented and accompanied by a written statement as to when and where presented.

DISTRICT PRIZES

The awarding of District prizes shall be the responsibility of the District Prize Award committee which shall be appointed annually by the District Vice-President and shall consist of not less than three Members or Fellows of the Institute. Judges of oral presentation of Student papers need not be the same as judges of written presentation, and they may include Associate Members or non-Institute members when necessary. The District prizes will be presented at a meeting within the District or at some other meeting upon approval of the District Executive Committee.

The District Prizes comprise (a) a best paper prize for any *Transactions* paper prepared by a resident of the District consisting of a certificate and $75, and a second prize consisting of a certificate and $50; and (b) a best paper prize presented to an undergraduate student member in District competition consisting of a certificate and $25, and a second student prize consisting of a certificate only.

(a) Best District Transactions Paper:

All *Transactions* papers presented during the administrative year, nominally August 1 to July 31, will be considered for District prizes without formal offering in competition. *Transactions* papers selected by Technical Committees of the Divisions and the General Committees for consideration as Institute prize papers will be classified according to District allocation, as determined by the residency of the author or authors. In the case of member coauthors from more than one District, a *Transactions* paper shall be eligible in all such Districts. A list of these *Transactions* papers for each District shall be forwarded by the Headquarters staff to the District Secretary for consideration as the District prize papers. In addition to these papers, each District may include for consideration as District prize papers, any eligible *Transactions* paper, whether or not it is among those called to their attention by Headquarters. A paper is eligible to receive both Institute and District prize awards.

(b) Best Student Paper:

The District Student Prize Papers competition is limited to papers which have received first prize in a Branch competition.*

SECTION PRIZES

The awarding of Section prizes shall be the responsibility of the Section Prize Award Committee which is appointed annually by the Section chairman and shall consist of not less than three Associate Members, Members, or Fellows of the Institute.

Prizes also are available for papers presented by Section members, but because of the wide variation in the character of the Sections, no very definite rules are provided. A sum of $100 is available for each Section to be divided at the discretion of the Section, but with a maximum of $50 for any one prize and a certificate for each winner. When three or more papers are submitted for competition to the Secretary of the Section, arrangements shall be made for presentation before the Section at a meeting set aside for that purpose and a committee selected to judge the contest.

The award of the Section prize will be made at a meeting of the Section.

BRANCH (UNDERGRADUATE) PRIZES

The Branch Prize Award Committee shall be appointed annually by the Student Branch Counselor and shall consist of not less than the three Associate Members, Members, or Fellows. A non-Institute member may be selected.

Two awards for each Branch are available. The first prize consists of a certificate and $10 plus an allowance of 17½¢ per mile, one way, for 600 miles or less and 13½¢ per mile for the remaining distance to the District Student Prize Paper Competition (computed on measured ruler distance on a map of the United States scaled not less than 35 miles to the inch between origin and destination). The second prize consists of a certificate. When three or more papers are submitted to the secretary of the Branch, arrangements shall be made for presentation before the Branch at a meeting set aside for that purpose and committees selected to judge each such contest.

It is not the primary purpose of student papers to contribute to the technical advancement of the profession; they should constitute a vehicle for the training and stimulation of future contributors to the profession. To this end, emphasis has been placed on written presentation and the exercise of engineering thinking rather than on technical value. The papers shall be graded in accordance with the following basis:

A. Basis for grading written presentation—66 per cent. Originality—17 per cent. (a) Originality should be interpreted to give credit for results, investigations, procedures, and conclusions that are primarily those of the author. A general guidance from others and the literature is acceptable. (b) Originality can be evidenced by an unusual, imaginative, or concise treatment of a subject.

Both (a) and (b) should be present to a reasonable degree to receive full credit.

Analytical treatment—16 per cent.

Interest—16 per cent.

Mode of expression—17 per cent. (1) Logical organization of material and clarity of presentation. (5 per cent). (2) Concise and coherent expression of thoughts in good English. (4 per cent). (3) Effective and judicious use of illustrative material. (4 per cent). (4) Adequate introduction and closure. (4 per cent)

B. Basis for grading oral presentation—34 per cent. Speaking technique—12 per cent. Style (organization of material)—12 per cent. Introduction and conclusion—5 per cent. Discussion—5 per cent.

The award of the student prizes should be made at a meeting of the Branch.

Institute and District prizes for student papers are also provided as indicated under Institute Prizes (Section *c*), and District Prizes (Section *b*).

*Additional prizes provided by the Members-for-Life Fund include a trip to the Summer General Meeting for the first prize, twenty-five dollars for second prize, and fifteen dollars for third prize.

Future trend to new power sources evidenced at Fall General Meeting

Power generation has been looked upon by some electrical engineers as a less glamorous segment of electrical engineering than other areas such as communications and electronics. Any of these engineers who may have attended AIEE's recent Fall General Meeting in Detroit should have come away with the feeling that power generation most assuredly will be one of the most exciting and rapidly developing areas in electrical engineering for some time to come.

Rotating machinery as used for power generation has had relatively few drastic innovations over the years. But now, technological advances have opened up totally new concepts for the generation of electric power. Stimulating and well-attended sessions at Detroit were filled with discussions of ion-exchange membrane cells, hydrogen-oxygen fuel cells, generation of electric power from high-velocity gas jets, magnetohydrodynamic generation in central station power plants, use of hydrocarbons in fuel cells, ion-exchange fuel-cell batteries, fusion power generation with mirror machines, and solar-powered thermionic generators.

The significance of the technological changes in the power generation field can perhaps be best illustrated by the remarks of some of the speakers at Detroit.

Mr. J. D. Flynn of the Cincinnati Gas and Electric Co. said: "Fuel cells present both a promise and a threat to the electric utilities. Their remarkable efficiencies promise to lower production costs of electricity. But since they are efficient in small sizes as well as large, potentially they can put each home owner in the power plant business."

"Efficiency is not their only contribution to successful large-scale power generation," Mr. Flynn continued. "Their simplicity of design and manufacture certainly indicates that their capital cost will be considerably less than the complicated turbogenerators of today." Mr. Flynn's remarks in full may be found in *Electrical Engineering*, Nov., 1961, p. 828.

In a paper by R. G. Mills of Princeton University, the author stated that if the next 2 years show as much progress in fusion research as the past 2 years, we will find a fusion reactor power plant is practically possible. And if we assume that a fusion reactor is possible, there will be many engineering problems involved in getting the energy out of the reactor.

A British engineer, D. J. Harris of the University of Sheffield, Sheffield, England, described various schemes for generating electric power by means of high-velocity gas jets. He said that the advantages of a practical generator of this type "are so great that there is every inducement for further work to be done."

In describing a high-power tunnel-diode static inverter for use with fuel cells, J. M. Marzolf of the Naval Research Laboratory, Washington, D. C., stated that new and improved materials and techniques have "tremendously improved the so-called unconventional power supplies," such as thermoelectric, thermionic, and fuel cells. These devices produce high direct current but low voltage, Mr. Marzolf said, and a static inverter "is believed to be the only practical way at the present time to transform the low voltage of single cells to the useful practical output voltages required by most utilization equipment."

The preceding comments, only a few among many on the subject of power sources, indicate that the many branches of electrical-electronic engineering, plus physics and chemistry, may all have to work hand in hand if the future power needs of the world are to be satisfied. Those attending the Fall General Meeting were presented with a thorough, up-to-date progress report on new power sources as well as an indication of the many engineering problems still to be solved.

Computer Conference scheduled December 12-14 in Washington, D. C.

The 1961 Eastern Joint Computer Conference (EJCC), the first national computer conference sponsored by the American Federation of Information Processing Societies (AFIPS), will take place December 12-14 at the Sheraton-Park Hotel, Washington, D. C.

AFIPS was created on May 10 in order to organize the advancement and diffusion of knowledge of the information processing sciences at all levels and to all media. The founding societies of AFIPS include AIEE, the Association for Computing Machinery, and the Institute of Radio Engineers.

Registration for the conference will begin December 11 at 2:00 p.m. in the main lobby of the Sheraton-Park Hotel. The registration fee for members of participating societies will be $8; for nonmembers, $10, and for students, $2. Another dollar will be charged for the *Proceedings* which will be given out at the registration desks.

For persons wishing to stay at the Sheraton-Park, where all conference activities will take place, the following accommodations will be available:

Single rooms	$ 9.85 — $16.50
Twin-bedrooms	13.85 — 20.00
Parlor and one bedroom suites	17.50 — 35.00
Parlor and two bedroom suites	55.00 — 65.00

All rooms contain bath, air conditioning, radio, and television.

Selected motion pictures on computers and data processing will be shown in the Cotillion Room December 12-13 and in the Assembly Room on December 14.

INSPECTION TRIPS PLANNED

Arrangements have been made for visits to several installations in the Washington, D. C., area. All trips will be conducted on Tuesday evening, December 12, and a limited number of free tickets will be available. After a cocktail party, buses will leave from the Sheraton-Park.

Four field trips will be held, as follows:

David Taylor Model Basin and Army Map Service. The model basin will feature the LARC, the *SC-4020*, and IBM *7090*. The map service will demonstrate the *MH-800*, integrated mapping equipment, and the *EECO-1000* computer language translator.

Goddard Space Flight Center. Operated by the National Aeronautics and Space Administration, the Center will demonstrate a variety of large-scale computing equipment, and other features of the new laboratory.

Bureau of the Census. The FOSDIC equipment will be seen in operation, as well as other types of equipment used in processing census data.

Farrington Electronics, Inc. The latest commercial types of optical character-reading machines will be demonstrated, and a visit to their production facilities will be included.

SOCIAL ACTIVITIES ARRANGED

Three social events have been scheduled. A cocktail party will be held Tuesday, December 12, at 6 p.m. in the Cotillion Room at a cost of $4.50. The conference banquet will take place Wednesday, December 13, at 7 p.m. in the Sheraton Hall Ballroom at a cost of $8, with cocktails served at 6:15 p.m. in the Garden Foyer. A speaker, to be announced later, will be featured. On Thursday, December 14, a noonday luncheon will be held in the Cotillion Room for which each person will be charged $4; a speaker will be named at a later date.

A special room at the Sheraton-Park Hotel will be reserved as a ladies' activities meeting place. Coffee will be served daily and ladies may register for the activities planned for them.

Tuesday, December 12, will be Get Acquainted Day for the ladies. They will be addressed by a speaker at a luncheon which will be followed by a short sightseeing tour in the afternoon. All ladies are invited to attend the cocktail party in the evening.

A theater party will be held by the ladies on Wednesday, December 13, in the afternoon, preceded by luncheon. The ladies are invited to attend the banquet Wednesday evening.

Also for the ladies sightseeing tours are being arranged for Thursday, December 14, which include visits to some of the embassies on Embassy Row.

Exhibits will be shown during the 3-day conference in the Exhibition Hall, Continental Room, and Burgundy Room.

TECHNICAL PROGRAM GIVEN

The preliminary technical program of the conference follows:

TUESDAY, DECEMBER 12

10:00 a.m. Opening Session

Moderator: *B. G. Oldfield*, IBM Federal Systems Div., 1961 EJCC program chairman

Opening Remarks:
Jack Moshman, C-E-I-R, Inc., 1961 EJCC chairman
W. H. Ware, Rand Corp., AFIPS chairman
Keynote Address: *D. L. Bibby*, executive vice-president, Remington Rand Div., Sperry Rand Corp.

2:00 p.m. Afternoon Session

Total Systems in Real Time

Session Chairman: *J. H. Burrows*, Mitre Corp.
Multilevel Programming in a Real Time System
A. B. Shafritz, A. E. Miller
Auerbach Electronic Corp.
Project Mercury Real-Time Computational and Data-Flow System
S. I. Gass, W. K. Green, J. E. Hamlin, R. Hoffman, R. D. Peavey, A. Peckar, M. B. Scott, IBM Federal Systems Div.

WEDNESDAY, DECEMBER 13

9:00 a.m. Morning Session

Systems Simulation

Session Chairman:
Jack Sherman, Lockheed Aircraft Corp.

Programming Language Standardization—A Panel Discussion

Moderator: *H. S. Bright*, Data Processing Group, BEMA, and chairman ASA X3 Committee
A Simulation Model for Data System Analysis
Leon Gainen, Rand Corp.
A General Purpose Systems Simulation
Geoffrey Gordon
IBM Advanced Systems Development Div.
Use of a Combined Analog-Digital System for Re-entry Vehicle Flight Simulation
Dr. Allan Wilson, General Dynamics—Astronautics
Combined Analog-Digital Simulation
A. J. Burns, R. E. Kopp
Grumman Aircraft Engineering Corp.
Contrans—(Conceptual Thought Random-Net Simulation)
David Malin, Walter Johnson High School

The Current Status of Programming Language Standardization: A Panel Discussion

Moderator: *H. S. Bright*
Panel Members:
C. A. Phillips, Dept. of Defense, and chairman, Codasyl Executive Com.
A. J. Perlis, Carnegie Inst. of Technology, and chairman ACM Language Com.
R. E. Utman, Remington Rand Univac, and chairman Pro Tempore ASA Subcommittee X3.4
R. F. Clippinger, Minneapolis-Honeywell, EDP Div., and chairman ISO/TC 97 Working Group

2:00 p.m. Afternoon Session

Advances in Equipment

Session Chairman: *Dr. S. N. Alexander*, Nat'l Bureau of Standards
Digital to Voice Conversion.
Evan Ragland
Motorola Inc. Military Electronics Div.
Cram (Card Random Access Memory): Functions and Use.
Leon Bloom, Isador Pardo
Nat'l Cash Register Co. Electronics Div.
William Keating, Earl Mayne, National Cash Register Co. Data Processing Systems and Sales
The Logic Design of the FC-*4100* data-processing system
W. A. Helbig, A. Schwartz, C. S. Warren, W. E. Woods, H. S. Zieper, RCA West Coast Missile & Surface Radar Div.
Versatile Man-Machine Communication Console.
R. Green, P. Lazovick, J. Trost, A. W. Reickord
RCA Astro-Electronic Products Div.
Dataview, A General Purpose Data Display System
R. L. Kuehn, Aeronutronic, Div. of Ford Motor Co.
A Computer for Direct Execution of Algorithmic Languages.
J. P. Anderson, Burroughs Corp.
Eddycard Memory—A Semipermanent Storage
T. Ishidate, S. Yoshizawa, K. Nagamori
Nippon Elec. Co.

THURSDAY, DECEMBER 14

9:00 a.m. Morning Session

Communication Systems

Session Chairman:
Jack Strong, North American Aviation
Digital Data Transmission: The User's View
J. A. Perlman, Hughes Aircraft Co.
Tele-Processing Systems
J. D. Shaver, IBM Data Systems Div.
Communications for Computer Applications
A. A. Alexander, AT&T
The Saturn Checkout System
J. Heskin, Packard Bell Computer Corp.
Information Handling in the Defense Communication Control Complex
T. J. Heckelman, R. H. Lazinski, Communications Systems Div., Philco Corp.
An Automatic Digital Data Acquisition System for Space Surveillance
M. S. Maxwell, U. S. Naval Weapons Lab.
Four Advanced Computers—Key to Air Force Digital Data Communications System.
R. J. Segal
RCA Electronic Data Processing Div.

2:00 p.m. Afternoon Session

Programming and Applications

Session Chairman:
C. A. Phillips, Dept. of Defense
The Atlas Supervisor
T. Kilburn, R. B. Payne, Univ. of Manchester
D. J. Howarth, Ferranti Ltd.
A Syntax Directed Generator
S. Warshall, Computer Associates
An Automated Technique for Conducting a Total System Study
A. O. Ridgway, IBM Federal Systems Div.
Display System Design Considerations
R. T. Loewe, P. Horowitz
Aeronutronic Div. of Ford Motor Co.
Abstract Shape Recognition by Machine
M. E. Stevens, Nat'l Bureau of Standards
A Character Recognition System Which is Independent of Character Translation and Orientation
D. N. Buell, Chrysler Corp.
The Digital Computer as an Aid in the Diagnosis of Heart Disease
C. A. Steinberg, W. E. Tolles
Airborne Instruments Lab.
A. H. Freiman, M.D.
Memorial Sloan-Kettering Cancer Center
C. A. Caceres, M.D., *S. Abraham*
U.S. Public Health Service

The EJCC Committee follows: *Jack Moshman*, C-E-I-R, Inc., chairman; *W. L. Witzel*, Computer Concepts, Inc., vice-chairman; *H. R. Koller*, Patent Office, secretary; *Solomon Rosenthal*, United States Air Force Headquarters, finance; *Isaac Seligsohn*, International Business Machines Federal Systems Div., public relations; *Stavisky and Associates*, public relations consultants; *P. W. Howerton*, Central Intelligence Agency, *Proceedings*; *B. G. Oldfield*, International Business Machines Federal Systems Division, programs; *H. S. Forrest*, Control Data Corporation, hotel arrangements; *E C. Marden*, National Bureau of Standards, women's activities; *Mike Healy*, System Development Corporation, printing and mailing; *J. T. Harris*, Remington Rand Univac, registration; *C. A. Phillips*, Department of Defense, exhibits, and *John L. Whitlock Associates*, exhibits management.

The governing board of AFIPS include the following: Chairman—*Dr. W. H. Ware*, Rand Corp.; secretary—*Miss Margaret Fox*, Bureau of Standards; AIEE—*R. S. Gardner*, AIEE; *R. A. Imm*, International Business Machines Corporation; *C. A. R. Kagen*, Western Electric Company, and *Dr. M. Rubinoff*, University of Pennsylvania; Association for Computing Machinery—*W. Carlson*, E. I. du Pont de Nemours and Company; *B. Gilchrist*, International Business Machines Corporation; *Dr. H. Huskey*, University of California, and *J. D. Madden*, System Development Corporation; Institute of Radio Engineers—*Dr. W. Bucholz*, International Business Machines Corporation; *Dr. A. A. Cohen*, Remington Rand Univac; *F. E. Heart*, Lincoln Laboratory, and *H T. Larson*, Ford Motor Company.

Call for technical papers issued on precision electromagnetic measurements

The 1962 International Conference on Precision Electromagnetic Measurements, formerly the Conference on Standards and Electronic Measurements, will be held August 14-16 at the Boulder Laboratories of the National Bureau of Standards, Boulder, Colo.

Original papers in the following areas will be considered for presentation: (1) atomic frequency and time, (2) determination of conductivity and complex (tensor) electric and magnetic susceptibilities, (3) direct-current and low-frequency measurements, (4) radio frequency and microwave measurements, (5) quantum electronics in precision measurements, (6) electromagnetic measurements for space exploration, and (7) data reduction in precision instruments.

Titles and summaries will be accepted in English or French but papers will be published in English. As before, it is planned to publish a conference record by including the conference papers in one issue of the IRE (Institute of Radio Engineers) *Transactions on Instrumentation*.

Papers should be submitted to Dr. George Birnbaum, Hughes Research Laboratory, Malibu, Calif., and should be in the form of 500- to 1,000-word summaries.

The deadline for submission of summaries is March 15. Notifications of acceptance or rejection will be mailed by April 15. The full technical program will be announced about June 1. This, with the registration brochure, will be mailed to the following: those who attended the 1960 conference on this subject, members of IRE-PGI (Professional Group on Instrumentation), IRE-PGMTT (Professional Group on Microwave Theory and Techniques), and the AIEE Instrumentation Division.

Further details relating to the conference, including registration forms which will be available about June 1, may be obtained by writing to J. F. Brockman, National Bureau of Standards, Boulder, Colo.

This conference is sponsored by the Radio Standards Laboratory of the National Bureau of Standards, IRE-PGI, and the Instrumentation Division of AIEE. Previous conferences, in 1958 and

1960, each attracted more than 800 participants from industrial, university, and government laboratories throughout the world.

The change of name points up the basic aim of the conference, which is the advancement of standards and accurate measurement throughout the coherent frequency spectrum. In addition, the 1962 conference will give more emphasis to the impact of quantum electronics and space physics on precision electromagnetic measurements.

In its concern with the strictly technical aspect of measurement, this conference will not include papers describing the large-scale organization and operation of standards laboratories, as did the conferences of 1958 and 1960. The interest in both fields is so great that the two subjects may not be adequately handled in a single conference. The second field, however, may be covered in a second conference which would closely precede or follow the International Conference on Precision Electromagnetic Measurements.

The change in name also reflects the international aspects of the conference. There are few, if any, other conferences with the same basic goal, yet there is a need to exchange such knowledge on a global basis and also to actively support and advance international standardization in the electromagnetic area. This need is evidenced by the fact that inquiries concerning the 1962 conference have already been received from several laboratories in Europe.

Conference slated on electrical insulation

The National Conference on the Application of Electrical Insulation will be held February 19-22 at the Shoreham Hotel, Washington, D.C. The sponsors for this conference are AIEE and the National Electrical Manufacturers Association (NEMA).

Sixteen technical sessions are scheduled, with a total of 86 papers to be presented. Sessions have been divided into four groups: Insulation Materials Education, Distribution and Transmission, Rotating Machinery, and Electronics.

On February 19 there will be a Marketer's Dinner, and on February 20, a NEMA luncheon, followed by an AIEE luncheon on February 22. On February 21, the Unity of Action banquet will be held at which the main speaker will be General Bernard Schriever, U. S. Air Force, and at that time the Golden Omega Award will be made. This award is presented at each Electrical Insulation Conference to an outstanding leader in science and engineering. In 1959, the Golden Omega was awarded to Admiral H. G. Rickover, U. S. Navy, and the following year it was presented to Dr. Mervin Kelly of Bell Telephone Laboratories.

The conference regularly designates one day in its program for activities related to the marketing of electrical insulating materials, and this year it will take place on February 19. The program will include speakers of prominence in marketing circles.

An abbreviated program of events for the 4th Electrical Insulation Conference follows:

MONDAY, FEBRUARY 19

9:00 a.m. Registration

12:40 p.m. Tour of Naval Ordnance Laboratory

3:00 p.m. Marketer's Meetings

6:30 p.m. Marketer's Dinner

8:30 p.m. Get-Acquainted Evening

TUESDAY, FEBRUARY 20

9:00 a.m. Technical Sessions

9:00 a.m. Tour of Nuclear Reactor

12:00 noon NEMA Luncheon

1:30 p.m. Commercial Exhibits

WEDNESDAY, FEBRUARY 21

9:00 a.m. Technical Sessions

12:00 noon. Commercial Exhibits
(Buffet Luncheon and Exhibitor's Afternoon)

1:00 p.m. Tour of Goddard Space Flight Center

6:00 p.m. Unity-of-Action Banquet

THURSDAY, FEBRUARY 22

9:00 a.m. Technical Sessions

12:00 noon. AIEE Luncheon

12:00 noon. Commercial Exhibits

Conference Papers Open for Discussion

Conference papers listed below have been accepted by AIEE *Transactions* and will be open for written discussion until December 27. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, AIEE, 345 E. 47 St., New York 17, N. Y., on or before December 27.

60-136	**An Astatic A-C–D-C Comparator with Wide Frequency Range.** *J. Pawlat, J. Wolloch*
*60-344	**The Effect of Staging on the Performance of Thermionic Converters.** *G. N. Hatsopoulos*
*60-417	**Analysis and Synthesis with the "Complete" Equivalent Circuit for the Wide-Band Transformer.** *T. R. O'Meara*
60-868	**Stabilization of Fluid Servomechanisms by the Stability Factor Method.** *A. G. Fonda*
60-1289	**A Modified Limiting Nonlinear Theory of Eddy-Current Phenomena in Solid Iron.** *W. L. Shevel, Jr.*
61-85	**Servomotor Characteristics by Impulse Testing.** *H. R. Weed*
61-168	**Microwave Devices with Field Emission Cathodes.** *J. R. Fontana, H. J. Shaw*
61-223	**High-Accuracy Digital-Analog Solid-State Speed Controller.** *F. T. Thompson*
61-645	**Speed Regulation by Digital Methods.** *R. R. Potts*
61-723	**An Electrically Controlled PAX—Its Design and Performance.** *Shegeki Yamato, Kenya Watanabe, Ko Muroga, Jiro Okuda*
61-778	**Speech Volumes on Bell System Message Circuits.** *K. L. McAdoo*
61-816	**Comparative Transmission Characteristics of Polyethylene-Insulated and Paper-Insulated Communication Cables.** *T. C. Henneberger, M. D. Fagen*
61-817	**The Relative Merits of Time-Division Multiples Versus Space Division as a Mode of Operation for Electronic Telephone Exchanges.** *J. G. Pearce*
61-887	**Application and Performance of Insulations for 500 C Hypersonic Aircraft Generators.** *R. L. Balke, C. H. Merrifield, J. A. Dimond*
61-889	**Optimizing Simple Circuitry for Reliability and Performance of Failure Mode.** *J. R. Hanne*
61-891	**Static Inverter with Neutralization of Harmonics.** *Andress Kernick, J. L. Roof, T. M. Heinrich*
61-906	**Problems in the Selection and Testing of Nickel Cadmium Batteries for Satellites.** *F. Albrecht*
61-911	**Solar-Cell Performance with Concentrated Sunlight.** *R. J. Tallent, Henry Oman*
61-913	**Voltage Modulation on Aircraft Electric Power Systems as a Function of the Flexibility of the Alternator Drive Shaft.** *M. G. Flugstad*

*No preprints available

Preprints may be purchased at 50¢ to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 345 E. 47 St., New York 17, N. Y.

Future Meetings of Other Societies

National Association of Home Builders, Dec. 3-7, Exposition Center, Chicago, Ill. Air-Conditioning and Refrigeration Institute, 1346 Connecticut Ave., N.W., Washington 6, D.C.

Beryllium Corporation of America, Conference on Beryllium Metallurgy, Dec. 4-5, Washington Square Center, New York, N.Y. Office of Information Services, New York University, Washington Square Center, New York 3, N.Y.

2nd Annual Seminar on Reliability in Space Vehicles, Dec. 5, Rodger Young Auditorium, Los Angeles, Calif. N. Khoury, Space Technology Laboratories, P. O. Box 95001, Los Angeles 45, Calif.

19th Electric Furnace Conference, Dec. 6-8, Penn-Sheraton Hotel, Pittsburgh, Pa. American Institute of Mining, Metallurgical, and Petroleum Engineers, 345 E. 47 St., New York 17, N.Y.

Metal Joining Symposium, Dec. 11-13, Pennsylvania State University, University Park, Pa. College of Engineering and Architecture, Dept. of Industrial Engineering (same address).

American Society of Agricultural Engineers, Winter Meeting, Dec. 12-15, The Palmer House, Chicago, Ill. Air-Conditioning and Refrigeration Institute, 1346 Connecticut Ave., N.W., Washington 6, D.C.

Wright Brothers Lecture, Dec. 18, Washington, D.C. Institute of the Aeronautical Sciences, 2 E. 64 St., New York 21, N.Y.

Annual Meeting, Pacific Southwest Section, ASEE. Dec. 28-29, Stardust Hotel, Las Vegas, Nev. W. D. McIlvaine, Secretary, Same address, Dept. of Engineering, University of California, Los Angeles 24, Calif.

8th National Symposium on Reliability and Quality Control, Jan. 9-11, Statler Hilton Hotel, Washington, D.C. Institute of Radio Engineers, 1 E. 79 St., New York 21, N.Y.

ASHRAE, Semi-Annual Meeting, Jan. 28-31, Chase-Park Plaza Hotel, St. Louis, Mo. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 345 E. 47 St., New York 17, N.Y.

Symposium on Thermophysical Properties, Jan. 24-26, Princeton, N.J. D. F. Lype, Chairman, Committee on Thermophysical Properties, American Society of Mechanical Engineers, c/o Thompson Ramo Wooldridge, 23555 Euclid Ave., Cleveland, Ohio.

OVERSEAS

Inter-American Conference on Mathematics Instruction, Dec. 4-9, Bogota, Colombia. Prof. Marcelo Alonso, Div. of Science Development, Pan American Union, Washington 6, D.C.

Atomic Industrial Forum, Conference, Dec. 5-9, Japan. 3 E. 54 St., New York 22, N.Y.

IEE, Medical Electronics Discussion Group, Dec. 8, Institution of Electrical Engineers, Savoy Place, London, W.C. 2, England.

International Heat Transfer Conference, Jan. 8-12, London, England. Secretary, Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W. 1, England.

Space instrumentation reviewed at Section meeting

Dr. H. L. Richter, Jr., manager of the Advanced Electronics and Information Systems Division of the Electro-Optical Systems Company, addressed the Los Angeles (Calif.) Section, AIEE, at the October 10 dinner meeting, on some problems that have developed in the competition with the Soviet Union for space laurels.

He reviewed some of the trends in space instrumentation from the early Explorer satellites to the present Ranger I systems. The types of scientific instruments carried by the space craft were described, and it was pointed out that the long lead times now required for instrument design restrict the flexibility and timeliness of the scientific data obtained by the space flights.

Rothschild

The need for a streamlined approach to the design of space exploration instrumentation was outlined to the AIEE Los Angeles Section at its October 10 dinner meeting. Shown at the meeting are: (left to right) *F. L. Goss, Los Angeles Section vice-chairman; Dr. H. L. Richter, Jr., the speaker, and L. L. Grandi, Los Angeles Section chairman*

This increase in lead times from a few months to 2 years results from both technical and managerial causes which were outlined in the talk. Dr. Richter advised that with the proper emphasis on the scientific uses of the space craft, advantage can be taken of certain types of subsystem standardization which can reduce the necessary design lead times again to a matter of months.

During the meeting, presentation of three Fellow certificates was made by Dr. R. W. Sorensen, Honorary Member and former AIEE president. The certificates were received by E. D. Barcus of the Pacific Telephone and Telegraph Company in Los Angeles; E. S. Condon, president of the Earl S. Condon Company in Los Angeles, and C. C. Ernst, president of the California Electric Power Company in San Bernardino, Calif.

L. D. Leonard appointed to AIEE student liaison post

L. D. Leonard's appointment as student co-ordinator for AIEE has been announced by N. S. Hibshman, Executive Secretary of the Institute. Mr. Leonard will act as liaison between AIEE and its student chapters, and also as consultant on the staff of *EE Digest*, quarterly newspaper published by the Institute for electrical engineering students.

The new staff member brings more than 10 years' experience in the college placement and personnel field to his post. He has worked in the areas of executive search, technical recruiting and employment, and personnel administration.

Mr. Leonard holds a bachelor's degree in Business Administration from Rutgers University, and a masters degree from New York University. From 1957, he was placement director for New York University's Undergraduate, Evening and Graduate Engineering Colleges, and the Liberal Arts College. Placement work for these colleges, with their combined enrollment of around 6,000, included finding employment for students, graduates, and alumni.

Mr. Leonard has also served as personnel director for an engineering service organization, Magnetronic Controls, and as personnel manager in industry. He is a member of the Eastern College Personnel Officers, the Metropolitan New York College Placement Officers Association, and the New York Personnel and Guidance Association.

Technical literature sought for overseas exchange

Through the international People-To-People Program, a technical literature project has been started for voluntary participation by American engineers and scientists to exchange information with their overseas colleagues. Spearheaded by Harvey Bumgardner of Detroit, Robert Lea of Long Island City, and Dr. Augustus Kinzel of New York, an Engineers and Scientists Committee has been formed and incorporated to implement the program.

The first phase of the work involved collecting, sorting, and shipping engineering journals, scientific publications, and technical papers to university deans in other countries.

University engineering and science departments in other countries are finding many uses for past issues of American technical publications in their courses of study. Deans, professors, and their many thousands of students welcome information from the United States in the fields of electrical, mechanical, chemical, civil, and industrial engineering and in all branches of science.

Tons of literature have already been processed and shipped from the supply of periodicals received from company and publishers' files. For the present, members should not send small quantities of their publications. Only bulk donations are desired from company libraries and publishers inventories. Four collection centers are now ready to receive donations, as follows:

East—Engineers and Scientists Committee, 36-02 Northern Boulevard, Long Island City 1, N. Y. Attention: E. C. Sparling

Midwest—Engineers and Scientists Committee, c/o Detroit Edison Company, 2000 Third Ave., Detroit 26, Mich. Attention: H. E. Bumgardner

Los Angeles Area—Engineers and Scientist Committee, c/o University of Southern California, Receiving Department, 925 W. 35 St., Los Angeles 7, Calif. Attention: Dean A. C. Ingersoll

For engineers and scientists interested in voluntary participation in the collection program or in personal exchange of friendships with their overseas counterparts, additional information may be obtained from the foregoing centers.

Eta Kappa Nu names professor an Eminent Member

Prof. A. D. Moore (M '24, F '43, Member for Life), electrical engineering professor, University of Michigan, Ann Arbor, Mich., became an Eminent Member in the Eta Kappa Nu Association, national electrical engineering honor society, on October 10 at ceremonies held in conjunction with the National Electronics Conference in Chicago, Ill.

Eminent Membership in Eta Kappa Nu is offered to individuals who by their technical achievements and contributions to society have shown themselves to be outstanding leaders in the field of electrical engineering and great benefactors of their fellow men.

Prof. Moore has been teaching for 44 years at the University of Michigan. As an honor graduate he secured his B.S. degree in electrical engineering in 1915 at the age of 20 from the Carnegie Institute of Technology. After graduation, he joined the graduate training program at Westinghouse Electric Corporation, and went to the University of Michigan the following year.

1962 John Fritz Medal awarded to C. H. Greenewalt

C. H. Greenewalt, president of E. I. du Pont de Nemours and Company, will be the 1962 recipient of the John Fritz Medal, according to an announcement by the John Fritz Board of Award.

Mr. Greenewalt was cited for "outstanding contributions . . . through leadership in research, in the translation of research achievements by way of sound engineering into useful products" and "able championship of the American free enterprise system both in the spoken and written word."

The John Fritz Medal was established in 1902 as a memorial to the engineer and steelmaker whose name it bears. Presented once a year for scientific or industrial achievement in pure or applied science, the Medal is sponsored jointly by AIEE, the American Society of Civil Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, American Society of Mechanical Engineers, and American Institute of Chemical Engineers. The United Engineering Trustees, Inc., is custodian of the award.

In 1922, Mr. Greenewalt joined the Philadelphia Works of E. I. du Pont de Nemours and Company as a chemist. He has been president, chairman of the Executive Committee, and a member of the Finance Committee of the company since 1948.

AIEE Section sponsors Energy Conversion Conference

A conference on Energy Conversion will be sponsored by the San Francisco Section, AIEE, and held in San Francisco, Calif., August 13-16.

This meeting will be devoted to reports on the state of the art and panel discussions on engineering aspects of applications in the energy conversion field. Included will be discussions on thermionics, photovoltaics, fuel cells, energy storage, thermoelectrics, and magnetohydrodynamics.

Authors interested in submitting papers are requested to furnish three copies of a brief summary by January 15 to H. N. Skow, General Program Committee chairman, Westinghouse Electric Corporation, 410 Bush St., San Francisco, Calif.

MEMBERS IN THE NEWS

A. J. Bisignani, Jr. (AM '58) has been appointed a commercial vice-president of the Federal Pacific Electric Company, Newark, N. J., assigned as manager of mixed-apparatus contracts. Mr. Bisignani came to Federal Pacific in 1954. **B. S. Burke** (M '58) has also been appointed a commercial vice-president and named manager of the company's Central Region. Mr. Burke came to Federal Pacific in 1957.

V. J. Cissna (M '30, F '57), electrical engineer, Tennessee Valley Authority (TVA), retired September 30 after 20 years' service. During 1936-61, Mr. Cissna was with TVA as system studies engineer and technical assistant to the branch chief, System Planning Branch, Division of Power Planning and Engineering. His duties involved the general supervision of all studies made on TVA's large a-c network analyzer. He served as consultant to TVA engineers on major technical problems and worked with engineers of municipal, co-operative, and industrial customers of TVA on joint technical problems.

Leo Dolkart (M '46, F '58, Member for Life), consulting electrical engineer, Chicago, Ill., has been named general chairman of the Illuminating Engineering Society's Institutional Committee for 1961-62. He has served on the AIEE Industrial and Commercial Power Systems Committee (1949-61).

B. J. George (M '43) retired September 30 from his position with the Kansas City Power and Light Company where he was employed as consultant in the industrial and commercial sales department. Since 1925, he was directly connected with the sale and application of electric service to industrial and commercial businesses and municipalities, large and small. In retirement, he will offer his services as a consultant in the application of rates, line extension problems, electric energy agreements, and competitive power.

Herman Halperin (AM '21, F '45, Member for Life), general staff engineer in the office of the manager of engineering, Commonwealth Edison Company, Chicago, Ill., recently retired from the utility after 40 years of engineering service. He started in 1921 as a junior engineer in the construction department and transferred to the engineering department in 1933.

Herman Halperin

R. K. Honaman (AM '16, F '36, Member for Life) has been elected chairman of the Board and chief executive officer of Floating Floors Inc., New York, N. Y., a company which provides environment facilities for data-processing systems and installations of a similar nature.

C. F. Ivins, Jr. (AM '47) has been appointed vice-president of marketing for Quan-Tech Laboratories, Inc., Boonton, N. J. Prior to joining Quan-Tech, Mr. Ivins was manager of Industrial Control Systems sales for Airborne Instruments Laboratory.

J. J. Lanigan (AM '61), project manager for the public relations department of Sylvania Electric Products Inc., has been called to active duty with the United States Army. Mr. Lanigan has been assigned to the 302 Civil Affairs Group at Fort Gordon, Ga.

E. R. Lind (AM '51) has joined the Electro-Mechanical Research, Inc., Sarasota, Fla., as systems analyst. Prior to this, Dr. Lind was a lead engineer at the Advanced Electronics Center of the General Electric Company, Ithaca, N. Y. For his initial assignment at Electro-Me-

chanical Research, Dr. Lind will be engaged in systems analysis of the test-instrumentation subsystem being designed and produced for the Boeing Company's Dyna-Soar space glider.

Four young engineers of Westinghouse Electric Corporation, all members of the aerospace electrical department (AED) at the Lima, Ohio, plant, have been awarded $5,500 and outstanding invention certificates for development work which resulted in more accurate and reliable electric systems for jet airliners. The award winners are: **L. R. Lowry, Jr.,** (AM '55), senior engineer in the control section; **J. R. Reeder** (AM '55), engineer in the AED control section; **N. F. Schuh, Jr.** (AM '50, M '57), manager of the AED's space technology section, and **R. E. Hulsey** (AM '54), advanced engineer in the control section. Mr. Hulsey was awarded $1,000, and the three other engineers $1,500 each.

J. W. Margosian (AM '44) has rejoined Polarad Electronics Corporation after an absence of a year to assume the position of technical assistant to the vice-president in charge of Polarad's Defense Products Division. Mr. Margosian's previous affiliation with Polarad was as electronic systems manager engaged in the development of special purpose miniaturized receiving and data storage systems for the Air Force. Prior to his return to Polarad, he was vice-president and director of engineering of Microwave Dynamics Corporation.

S. T. Maunder (AM '25, M '34), General Electric advanced engineering consultant, retired from General Electric after 38 years and accepted an assistant professorship of electrical engineering at the University of Massachusetts. Mr. Maunder's employment with the company's High Voltage Specialty Transformer Section, Holyoke, Mass., ended on September 29. Prior posts included design engineer, sales engineer and sales manager at the company's power transformer headquarters in Pittsfield, Mass., and supervisor, then manager of engineering at Holyoke. He was named consultant-advanced engineering in January.

J. P. Morrissey (M '24, Member for Life), president of the John P. Morrissey Electric Company, Inc., New York City, and State Senator of the 22nd District, was presented on October 19 with the Award to Distinguished Engineer in Public Service at the annual awards dinner of the New York Chapter of the New York State Society of Professional Engineers.

C. W. Moseley (M '44), R. H. Bouligny, Inc., Charlotte, N. C., received the Contractors Medal and Purse at the general meeting of the National Electrical Contractors Association on October 11 at Washington, D. C. Mr. Moseley received the award for his dedicated leadership and diligent personal efforts toward planning and promoting the organization of line construction contractors in effective regional chapters. This prize is one of a series of four national awards given under the James H. McGraw Award for Electrical Men.

A. E. Pringle, II (AM '36, M '51), president of the Pringle Electrical Manufacturing Company, has been named Fellow of the Standards Engineers Society, Inc., for his leadership in the development of policies and procedures within the industry and for their application within his own company. Mr. Pringle has served on the AIEE Industrial and Commercial Power Systems Committee (1952-61) and Standards Committee (1955-61).

New appointments announced by the development department of the Allis-Chalmers Manufacturing Company's Research Division are, as follows: **W. L. Ringland** (AM '36, M '44), chief engineer, electrical section; **R. C. Odell** (AM '40), administrative assistant, and **J. W. Timmerman** (AM '43), co-ordinator of consulting and laboratory services. Formerly chief engineer of the motor and generator section, Mr. Ringland has served on the AIEE Rotating Machinery Committee (1953-61). Mr. Odell was previously manager of the magnetohydrodynamics laboratory at Newport Beach, Calif. Mr. Timmerman formerly was chief development engineer at the Boston Works and later project engineer on the C Stellarator d-c distribution system.

J. P. Scanlan (AM '43, M '55) has joined Multi-Amp Electronic Corporation, Cranford, N. J., to assist in sales engineering of electrical test and calibrating units for checking relays, circuit breakers, other protective devices and meters, and high-voltage units for testing insulation. He was formerly a district engineer for Mutual Boiler and Machinery Insurance Company.

Guy Suits (M '41, F '47), General Electric vice-president and director of research, has been chosen to receive the 1962 Industrial Research Institute Medal. Dr. Suits was cited for "skill and leadership in promoting the growth of an industrial research laboratory enjoying world-wide recognition . . . interpreting research results to company management and the general public and . . . technological advisory services to the government of his country."

D. E. F. Thomas (AM '30, M '43) retired October 1 as staff and service division supervisor for the Detroit Edison Company, Detroit, Mich., after almost 36 years of service. Mr. Thomas joined Detroit Edison in 1925 as an electrical engineer in the research department.

W. J. Weisz (AM '49), manager of mobile and portable communications products in the Communications Division, has been elected vice-president, communications products, Motorola, Inc., Chicago, Ill.

R. F. Willett (AM '48, M '59) has been appointed vice-president and chief electrical engineer of Beiswenger, Hoch, Arnold and Associates, Inc., consulting engineers to the electric utility, chemical, and industrial industries, with offices in Cleveland and Akron, Ohio, and Jacksonville, Fla. Mr. Willett was formerly corporate electrical engineer for Interlake Iron Corporation, Cleveland, Ohio.

J. C. Woods (AM '23 F '53) retired from the Commonwealth Edison Company, Chicago, Ill., on October 31 after 39 years of service. Mr. Woods has served as an AIEE director (1955-59) and on the following AIEE Committees: Constitution and Bylaws (1958-1961, chairman 1958-59) and Lamme Medal (1960-63).

J. C. Woods

OBITUARIES

George Thomas Hays (AM '38, M '51), retired director of the underground division, engineering department, Dallas Power and Light Company, Dallas, Tex., died recently. Born September 7, 1895, in Marble Falls, Tex., he received the B.S. in electrical engineering in 1921 from the University of Texas. He joined the company in 1922 as a student engineer, subsequently became an engineer assigned to underground design and engineer-in-charge of underground design, and later was advanced to the position of director.

Hermann Ernest Kranz (AM '17, M '23, Member for Life), of Belleville, Mich., died September 2 at the age of 77. He was born June 15, 1884, in Minonk, Ill. Mr. Kranz received the A.B. degree from Lawrence College in 1909, and the B.S. degree in electrical engineering in 1914 and the electrical engineering degree in 1917, both from the University of Wisconsin. He was a former vice-president and chief engineer of Grigsby-Grunow Company, and had been associated with the Western Electric Company, Briggs and Stratton of Milwaukee, International Detrola of Detroit, and with Research Enterprises Ltd. of Toronto. Recently, he was with the Ordnance Corps of the United States Army at the Detroit Arsenal.

William H. Payne, Jr. (AM '45), supervising director of industrial arts for the public schools in Washington, D. C., died March 18. He was born October 3, 1905, in Washington, D.C., received the B.S. degree in 1938 from Howard University and the M.A. degree in 1946 from New York University. Mr. Payae entered the school system in 1928 as a teacher of general shop and applied electronics at Garnet-Patterson Junior High School. In 1946, he became a teacher of applied science at Armstrong High School, and remained in that post until his appointment as an industrial arts director in 1951.

Charles Borum Seibert (AM '32, M '50), professor of electrical engineering, West Virginia University, Morgantown, W. Va., died June 12. He was born June 1, 1908, in Martinsburg, W. Va. In 1930, he received the B.S. degree in electrical engineering from West Virginia University, and in 1932, the S.M. degree in electrical engineering from the Massachusetts Institute of Technology, both in electrical engineering. Mr. Seibert joined the university faculty as an instructor in 1934 and became a professor in 1951. A loan fund administered by the Student Affairs Office has been established at West Virginia University in memory of Mr. Seibert. The fund was established by contributions from his friends and will be used for short term loans to deserving students majoring in electrical engineering.

Stefan Kruger (AM '42, M '59), senior electrical engineer, Federal Electric Corporation, Paramus N. J., died recently. Mr. Kruger was born July 31, 1915, in Berlin, Germany, and studied electrical engineering at the Swiss Federal Institute of Technology. He was employed by Westinghouse Electric Corporation, Sharon, Pa., in 1939 as a design engineer. During 1942-45, he served in the U. S. Army, assigned to the maintenance of antiaircraft fire control equipment and received the Legion of Merit award for his invention of the Kruger antiaircraft plotting board. In 1945, he was assigned to the U. S. Office of Military Government for Germany as an analyst in the Economics Division. Mr. Kruger became an electrical engineer of the International Telephone and Telegraph Corporation in 1946, assigned to service in Europe. He came to New York City in 1954, when he founded the Columbia Plastics Corporation as its president. Two years later, Mr. Kruger became a design engineer and project leader for Marbarry Corporation in New York City and its subsidiaries. Since 1958, he was associated with the Federal Electric Corporation, a service subsidiary of the International Telephone and Telegraph Corporation, as a senior electrical engineer.

Dennis John Ford (AM '52, M '59), professor of electrical engineering, University of Pittsburgh, Pittsburgh, Pa. died October 3. Dr. Ford was born May 14, 1928. He received a B.S. degree in electrical engineering from Oregon State College in 1949, and an M.S. degree in electrical engineering and a Ph.D. degree from Northwestern University in 1951 and 1954, respectively. In 1953, he became an assistant professor at Northwestern University. In 1954, Dr. Ford was associated with the University of Pittsburgh as an assistant professor; later he became a Westinghouse associate professor of electrical engineering and, in 1960, a professor. A member of Sigma Tau, Eta Kappa Nu, Tau Beta Pi, and Sigma XI, Dr. Ford served on the AIEE Feedback Control Systems Committee (1958-61).

SUMMARIES OF AIEE PAPERS

Each month, Electrical Engineering *publishes authors' 75-word summaries of all serially numbered papers sold at General and District Meetings. Preprints of these papers may be purchased at 50¢ each to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to : AIEE Order Department, 345 E. 47 St., New York 17, N. Y.*

Communication

CP61-1114. **Radar-Tracking Accuracy Improvement by Means of Pulse-to-Pulse Frequency Modulation,** *W. P. Birkemeier, N. D. Wallace.* Angular scintillation tracking noise for simplified radar target models has been analyzed for monofrequency pulse radars. This paper extends to pulse-to-pulse frequency modulated radars and demonstrates that they offer a reduction in error. Improvement is derived as a function of tracking servo bandwidth, scintillation spectrum, and f-m regimen. The quality Δfe, defined as the minimum frequency shift required to achieve maximum improvement, is derived as a function of target model and radar parameters.

62-7 (I). **Minuteman Communication Cable Tests,** *E. A. Havens, J. H. Wolff.* The degree of reliability required for the Minuteman cable network dictates a new cable design, and specific information about its electrical, mechanical, and pneumatic performance. This paper describes testing programs to insure highest confidence in the final design. Pneumatic characteristics and electrical parameter verification tests for polyethylene-insulated and jacketed cables are described and results are shown. Comparative tests on resistance to electric surges, shield factor, crosstalk, and mechanical properties for various shieldings and outer jacketings are discussed.

General Applications

CP62-2. **Electrification — Devil or Angel?** *L. B. Curtis.* Many objections have been raised regarding railroad electrification. Sixteen of these are reviewed and conclusions reached as a result of answers to a questionnaire sent to the major electrified-railroad companies of the world. The results of this novel approach to the promotion of electrification in North America indicate that the objections are largely overrated. The author anticipates that the facts presented will induce railroad management to look with favor upon further electrification.

62-4 (II). **NS Savannah—Electric System in First Merchant Nuclear Reactor System,** *E. A. Geary.* In addition to normal considerations for shipboard electric plants, the design of plants for nuclear powered merchant vessels is predicated on the requirement for an uninterrupted source of power. Main, auxiliary, and emergency generating plants; automatic devices for generator synchronizing and power source transfer; and special interior communications and alarm systems, unique to nuclear powered vessels, effectively eliminate the probability of complete power loss on the *NS Savannah.*

62-6 (II). **Voltage Regulation of D-C Power Supply with Suddenly Applied Load,** *H. H. Hansen.* A method to obtain the voltage regulation of 6-phase and 12-phase double-way transformer rectifiers is presented. After the generator load power factor due to the transformer rectifier is obtained, a means of obtaining the generator voltage regulation is presented. The algebraic sum of these two voltage regulations is then the voltage regulation of the power supply with suddenly applied load.

CP62-16. **Modulation Circuits for the Line-Voltage Control of Electric Heating by Anticipated Thermostats,** *W. K. Roots.* Reduced voltage modulation and 2-stage modulation are compared. Reduced voltage circuits are examined, incorporating both shunt and series anticipation. A circuit combining both types of modulation is presented. Partial solid-state modulation is introduced and extended to cover sensing of wall temperatures. Demand control, shutdown, and photoluminescent features are described.

62-17 (II). **An Introduction to the Assessment of Line Voltage Thermostat Performance for Electric Heating Applications,** *W. K. Roots.* The key in-

dexes of thermostat performance in electric heating systems are explained. Response, offset, cycle time, droop, and similar terms are introduced, and basic methods for their measurement in the field and the laboratory are described. The correlation between field and laboratory tests is outlined with a brief mention of the NEMA test box. Modern thermostat components, such as snap action switches, shunt, and series anticipators are described. Two fundamental methods of modulation are introduced.

Industry

62-3 (II). **A Graphical Method of Evaluating the Describing Function,** *B. L. Deekshatulu.* Describing function for a nonlinear element is evaluated from the nonlinear characteristic without going to the output waveform, and is shown to be a fraction of a certain area obtained by a simple graphical construction. The method is applicable to all nonlinearities. Phase shift, if any, is also determined in terms of areas. A template is suggested to quicken the graphical procedure. Simple as it is, the method presented is believed to be novel.

62-8 (II). **Linear Multivariable Control System Design with Root Loci,** *E. Kinnen, D. S. Liu.* The design of multivariable control systems utilizing matrix formulations has often been considered, but problems of realizability and the effects of interaction are not usually considered. This paper describes the application of the root locus method to the design of realizable interacting linear control systems. Where the design specifications control system transient interactions rather than requiring noninteraction, the loci method provides a systematic application of familiar techniques to the procedure.

Instruments

62-18 (I). **The Impedance of Coil Placed on a Conducting Plane,** *T. J. Russel, V. E. Schuster, D. L. Waidelich.* Probe coils are used to determine the properties of metals on which the coil is placed. A necessary analysis and an equivalent circuit of the coil on a metal surface are presented here. The coil was assumed to have a ferromagnetic core, and the constants of the equivalent circuit were computed from the analysis. Experimental measurements were made to verify the theory.

62-21 (I). **Delay of Time Functions by Means of Frequency Domain Sampling,** *W. W. Wierwille.* Delays of finite duration time functions may be obtained by sampling in the frequency domain. The method is applicable when the delay time is greater than the waveform duration, and is particularly amenable to analog computer techniques. No special equipment is required. The holding feature of these machines permits delaying functions several minutes. A clear-cut error analysis can be made to insure economical use of the equipment for the accuracy required.

Science and Electronics

62-5 (I). **Comparison of Directly and Indirectly Measured Control Characteristics of Magnetic Amplifiers with External Feedback,** *W. A. Geyger.* Directly measured static control characteristics of the external-feedback type of magnetic amplifiers with Silectron, Orthonol, and Supermalloy tape cores are compared with the respective ordinary saturable characteristics obtained in a previous experimental study. With free even-harmonic conditions, minimized rectifier reverse-current effects, and moderate ampere-turn gain (up to about 100), there is good agreement between corresponding characteristics. With high ampere-turn gain (about 400 to 500) there are deviations which are not fully explained.

62-11 (I). **A Map Approach to the Solution of a Class of Boolean Functional Equations,** *K. K. Maitra.* Typically, simultaneous Boolean equations are expressed by a set of relations $F_i = f_i$; $i = 1,2, \ldots$, where the F_i and f_i are switching functions of N binary variables. In the solving of logical design problems a special type of Boolean equation is often encountered: $F(A_0,A_1, \ldots, A_{n-1},X_0,X_1, \ldots, X_{m-1}) = f(a_1,a_0, \ldots, a_k,X_0,X_1, \ldots, X_{m-1})$, in which the arguments A_i's and X_j's are binary variables and the a_i's are implicit functions of the A_i's only. This paper presents a somewhat new approach to solve this special class of Boolean functional equations. It is shown that the soultion function can be formulated and mapped on a vietch chart specially tailored to the problem, and all possible sets of solutions of the implicit functions a_i's which satisfy the original functional equation are obtained simultaneously.

Power

61-1094 (III). **The Theory of the Induction Machine with Conducting Sleeve Rotor,** *E. C. Guilford.* An idealized induction machine, with a conventional stator wound for excitation from a 2-phase source and a rotor of a conducting sleeve mounted upon a laminated iron cylinder is analyzed. Expressions for the developed electrical torque voltages induced in the windings are derived. The analysis includes the effects of the variation of rotor current density with depth within the conductor, and end effects due to closure of current paths inside the air gap.

62-1 (III). **Modern Control of Large Hydroelectric Generating Stations,** *R. H. Bruck.* A brief description is given of the evolution of control of large hydroelectric stations up to the present, and also plans for control of future plants and the John Day and Lower Monumental plants now under construction. The design for new stations provides the same control in the powerhouse control room that would be provided at a remote control station and is compatible with minimum modification with remote control from a central computer.

62-10 (III). **Auxiliary Cooling of Power Transformers,** *D. L. Levine.* Larger transformers have brought with them increased use of auxiliary cooling. Control of auxiliary cooling, particularly for forced-oil-cooled transformers has become more complex as the importance of the transformer has grown. The economics of cooling below temperatures required for normal operation are examined. Also, the problem of emergency operation without coolers is discussed. Recommendation is for simplified controls and for continuous operation of coolers on base-load transformers.

62-13 (III). **An Approach to Induction Motor Synthesis,** *W. H. Middendorf.* A design method for induction motors is described which is based on the use of a newly developed relation between the D^2L of the rotor and all normal customer and NEMA specifications except temperature rise. In developing this relation an equation giving motor torque in terms of motor dimensions is given. This is of special interest since it does not involve equivalent circuit parameters. The equations are found to give accurate results.

62-14 (III). **Time Constant Overload Behavior of Oil-Filled Transformers,** *H. Reber.* Two methods are described that enable calculation of transient parameters for simple exponential relationships, whenever certain test data are available. These two methods were specifically derived for transformer cooling and may be applied whenever top oil temperature rise measurements over a reasonable part of a heat run are available. After the transient parameters have been determined, overload temperature may be calculated and loss of life estimated.

62-15 (III). **Observations on the Development of Arc Interrupters of Small Physical Volume for Industrial Ratings,** *W. K. Roots.* An interrupter for a 50-kiloampere 600-volt industrial circuit breaker to be mounted four high in a switchboard and meeting unusually onerous interrupting-test duty requirements was developed. Short-circuit tests conducted on experimental arc chutes containing baffles and cooling rods are summarized. Performance characteristics are illustrated by oscillograms correlated with excerpts from high-speed cine film records.

62-20 (III). **A Mathematical Basis for a Protective Relay with Conic Pickup Characteristics,** *J. E. Skuderna.* A mathematical basis and suggested circuitry are proposed for a unique distance relay. The pickup characteristics, plotted on an R-X diagram, can be made to assume the shape of any conic section. Applications for protection of power systems emphasize use for protecting long, heavily loaded transmission lines.

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NAME _____ (LAST / FIRST / MIDDLE) HOME PHONE _____

HOME ADDRESS _____ (NUMBER / STREET / CITY-ZONE / STATE)

DATE OF BIRTH _____

EDUCATION—Give Complete Details—Use Separte Sheet If Necessary

LAST SCHOOL ATTENDED	NAME-LOCATION OF SCHOOL	ENCIRCLE LAST YEAR COMPLETED	MAJOR COURSE AND OPTION	DEGREE	LAST YEAR ATTENDED
COLLEGE OR UNIVERSITY		1 2 3 4			19
OTHER		1 2 3 4			19

EMPLOYMENT RECORD—Positions Held Including Present
USE SEPARATE SHEET IF NECESSARY

FROM	TO	NAME OF EMPLOYER	LOCATION	NATURE OF POSITION	SALARY	REASON FOR LEAVING
MONTH 19	MONTH 19					
MONTH 19	MONTH 19					

POSITION PREFERRED _____

This information will be held in confidence.
Present employer will not be contacted without your permission.

All qualified applicants will receive consideration for employment without regard to race, religion, creed, color, national origin or ancestry.

MAIL TO

J. L. Lisenbee
Personnel and Safety Department
CENTRAL ILLINOIS PUBLIC SERVICE COMPANY
ILLINOIS BUILDING — 605 EAST ADAMS STREET
SPRINGFIELD, ILLINOIS

NEW/IMPROVED PRODUCTS

(*Continued from page 8A*)

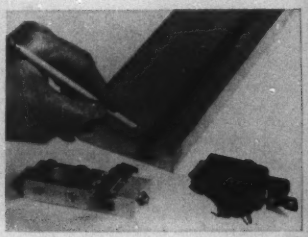
nal seal will be available in the future on any high-temperature electric furnace with silicon-carbide elements that is manufactured by this manufacturer. *Hevi-Duty Electric Co., 304 Hart St., Watertown, Wis.*

Magnetic Amplifier . . .

Precise electrical control applications are possible with a new proportional power magnetic amplifier now obtainable. Coupled with a standard saturable core reactor, the new amplifier is the electrical equivalent of an equal percentage valve. A linear change in the system input will produce a percentage change in process power. The type 300 SRMA D 73312 amplifier operates from a 110-volt, single-phase, 60-cycle line with a 0-5 ma input from any automatic controller installation. Output from the magnetic amplifier is normally zero to 85 volts d-c. *Hevi Duty Electric Co., 304 Hart St., Watertown, Wis.*

Brush Holders . . .

Versatility of aluminum extrusion design, together with a newly developed coiled extension band spring, makes a new line of electric motor brush holders unique. A slip-ring brush holder has three parts including the spring package,



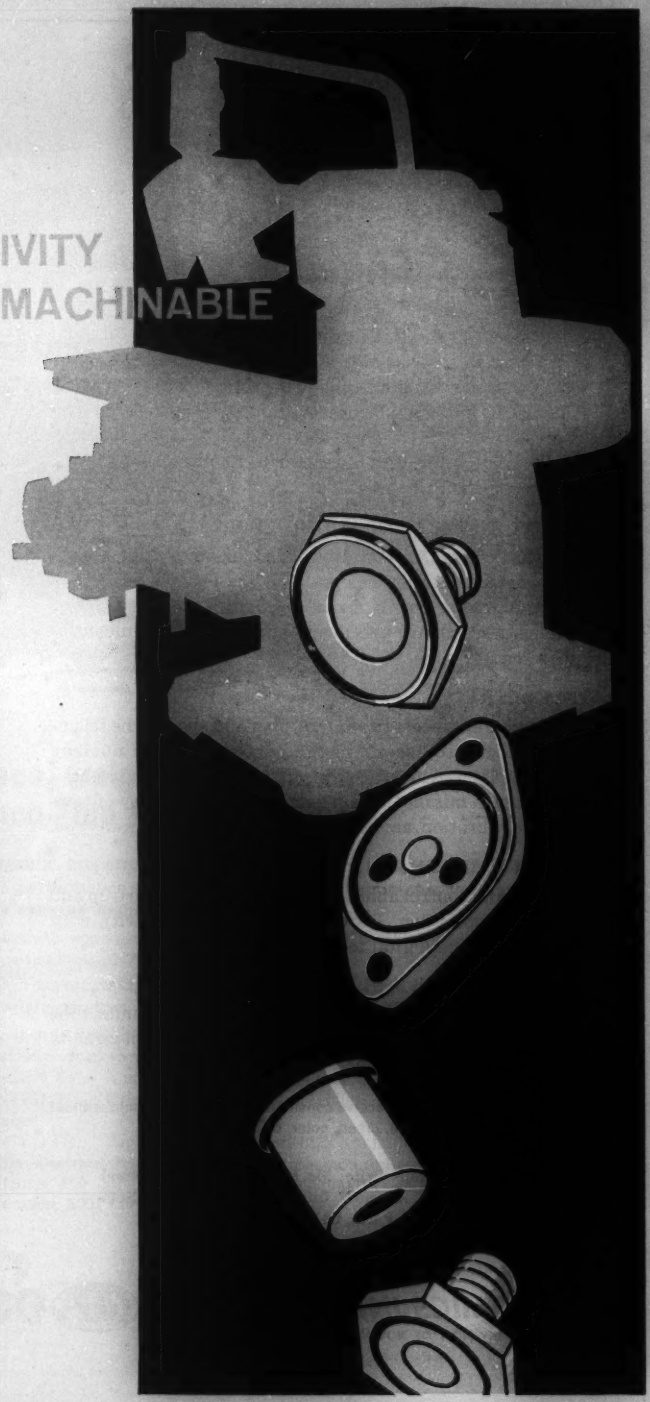
compared to five components used in the conventional brass brush holder. The new brush holders are available in sizes ranging from fractional hp up to the largest motor size. The units have improved commutation qualities as a result of spring pressure. *Howe Engineering Co., Inc., 5800 Mass. Ave., Indianapolis, Ind.*

Electromagnetic Flowmeter . . .

An output signal of 1-5 ma d-c is provided by the Mag-Pipe, a new electromagnetic flowmeter. The output signal may be transmitted with 0.5 per cent accuracy up to 10,000 feet. The meter is claimed to be ideally suited to many of the viscous liquids and suspensions found

(*Continued on page 20A*)

THESE TOUGH, HIGH-CONDUCTIVITY COPPERS ARE MACHINABLE



A semi-conductor base is a typical application of electrical copper demanding—

- strength to withstand high torque,
- high thermal conductivity,
- machinability.

Ideal for such requirements are these five alloys from Anaconda:

DLP Copper-104 (deoxidized low phosphorous)

OFHC* Copper-120 (oxygen-free high conductivity)

Tellurium Copper-127

Chromium Copper-999

Amzirc* (Zirconium Copper)-134

Each of the above provides a slightly different combination of desirable properties, and all can be machined as required to achieve necessary accuracy and maintain reasonable production costs.

Anaconda Specialists can help you select the right alloy and form of metal—and the manufacturing method best suited to meet your design and fabrication problems. They can help you utilize cost-cutting techniques, such as roll threading of studs, and advise you on welding and brazing procedures. Whatever your problems, Anaconda offers specialized technical help.

Anaconda Publication C-34 provides useful data on composition, typical physical and mechanical properties, forms available, and fabrication methods. For this publication, or technical assistance in applying these electrical coppers, address: Anaconda American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 61-916

*Trade-marks of American Metal Climax, Inc.

ANACONDA®

AMERICAN BRASS COMPANY

Control and Instrumentation Engineers

A key research and development program is now underway at Atomics International to design long-life, compact, lightweight nuclear reactors that will provide auxiliary power systems for space applications. Many interesting problems exist to challenge electrical engineers who want to relate their present experience to reactor technology in any of the following areas:

FLIGHT INSTRUMENTATION DESIGN

Electrical control system design and/or aircraft or missile flight instrumentation design. Will establish flight instrumentation requirements, block diagrams for flight and test systems, preliminary specifications for each instrument or subsystem.

TELEMETRY

Responsible engineers to analyze, plan and specify the telemetry required to ascertain the performance of nuclear power plants during space tests. The individuals must have experience in missile instrumentation and telemetry of temperature, vibration, acceleration, etc. BS or MSEE preferred.

CONTROL ANALYSIS

Dynamic and control analysis including system start-up and full power operation. BS or MSEE plus familiarity with latest analog and digital techniques required.

CIRCUIT DESIGN

Electronics engineers experienced with both vacuum tube and magnetic devices to design and develop control circuits for compact nuclear power plants.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

For specific details write: Mr. E. M. Newton, Personnel sonnel Office, Atomics International, 8900 DeSoto Avenue, Canoga Park, California.

ATOMICS INTERNATIONAL
DIVISION OF NORTH AMERICAN AVIATION

NEW/IMPROVED PRODUCTS

(*Continued from page 18A*)

in the chemical, food, paper, plastics, rubber, and sewage treatment industries. A factory-calibrated, fixed-range model is standard. Optional dual-range versions are provided with a range switch and full-scale vernier adjustments. Full-scale calibration between 0.5 and 30 ft/sec velocities may be set up quickly. *Taylor Instrument Companies, Rochester 1, N. Y.*

Machine Feed Control . . .

Use of automatic feeds for tapping machines, drill presses, punch presses, multi-spindle units, and other similar devices is simplified by a new machine feed control. It can be applied to electrical, hydraulic, or pneumatically controlled automatic feeds. The only auxiliary equipment needed for installation consists of a standard limit switch and an electrically operated valve. *Guardian Electric Mfg. Co., 1550 W. Carroll Ave., Chicago 7, Ill.*

Insulation Tester . . .

Steady testing voltage without dependence on batteries or other current supply is provided by the pocket-size Mark III Megger. Three ranges of instruments are available: 100 v d-c, 0.02–20 megohms; 250 v d-c, 0.05–50 megohms; and 500 v d-c, 0.1—100 megohms. Each model has a double scale and selector switch for 0–10,000 ohms. *James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.*

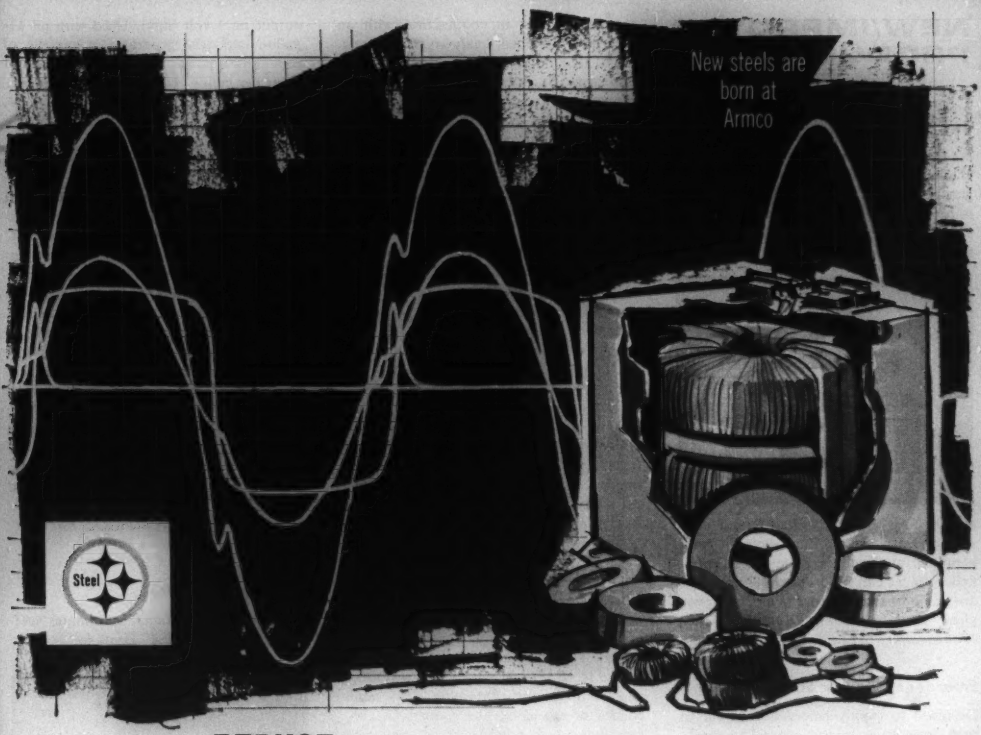
Motor-Starting Relay . . .

Installation of this new motor-starting relay is accomplished by simply pushing it onto the terminal pins of hermetic compressors with pin-type terminal clusters. The relay cover and spool are made of a strong, high-temperature phenolic. The internal mechanism consists of a solenoid coil, a steel armature, and a bridging-type contact arm. *Metals & Controls Inc., P. O. Box 898, Attleboro, Mass.*

Battery Charger . . .

Designed especially for use by electric utilities, railroads for communication and signaling, and industrial applications, a new self-contained, static battery charger is now available. The unit maintains its output voltage from no load to full load within ±1 per cent of the adjusted nominal voltage with ±10 per cent changes in line voltage. The charger is suitable for lead-acid and nickel-cadmium batteries and is available in standard models with charging rates up to 100 amperes. Efficiency ranges from 75 to 80 per cent. *Fansteel Metallurgical Corp., Rectifier-Capacitor Div., N. Chicago, Ill.*

(*Continued on page 22A*)



REDUCE
Core losses, weight and size, copper requirements With Armco Thin Electrical Steels

Exceptional magnetic properties of Armco Thin Electrical Steels make it possible to improve performance and cut cost of electrical apparatus for operation at 400 to 2000 cps and higher.

They offer you these opportunities because of a unique combination of magnetic and physical properties:

Exceptionally high permeability • Low hysteresis loss • High lamination factor • Minimum interlaminar loss • Properties fully developed at the mill.

These Armco Steels are available in three different grades that enable you to select the material most precisely suited to your requirements.

Armco TRAN-COR T . . . A non-oriented grade; produced in 7 and 5 mil thicknesses.

Armco ORIENTED T . . . Oriented grade; best permeability in rolling direction; 4, 2, and 1 mil thicknesses.

Armco ORIENTED TS . . . Super-oriented with very high permeability; 4 mil thickness.

Use Armco Thin Electrical Steels to improve performance and reduce both size and cost of your products. For complete information, including design curves, just write **Armco Steel Corporation, 3001 Curtis Street, Middletown, Ohio.**

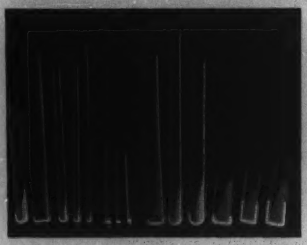
ARMCO **Armco Division**

NEW/IMPROVED PRODUCTS

(*Continued from page 20A*)

Channel Slot Wedges . . .

An expanded line of high-temperature channel slot wedges for electric motors, generators, and other rotating equipment is now available. The wedges save valuable winding space in the slot. Sixty-six standard sizes cover class *H* (silicone



glass), class *F* (epoxy glass), and class *B* (polyester glass). Each type is color identified and wedges pretested at specified voltages can be ordered. The wedges are made of two or more layers of woven glass cloth. *Silicone Insulation, Inc., 1383 Seabury Ave., Bronx 61, N. Y.*

Emergency Power Sources . . .

Designed to supply emergency power to such systems as microwave relays, early warning stations, and electronic control devices of all kinds, this new emergency power source operates from reserve battery sources of 120, 130, or 140 volts d-c to supply up to 750 va of 115 volt a-c 60-cycle power. The unit is capable of picking up full load from standstill within 50 milliseconds after application of d-c power to the unit by a control circuit. *Federal Pacific Electric Co., Cornell-Dubilier Electronics Div., 118 E. Jones St., Fuquay Springs, N. C.*

Aluminum Conduit Fittings . . .

A completely redesigned and modernized line of die-cast copper-free aluminum conduit fittings, called the Mark 9 series, is on the market. The new fittings have greater internal room for easier wiring, self-retaining cover screws for rapid assembly; long hubs for firm wrench grip; taper-tapped, full-cut threads for rigid joints; and integral bushing for easy pulling of conductors. The fittings are available in a wide selection of types and sizes from ½ to 4 inches with a complete selection of wiring devices. *Crouse-Hinds Co., Dept. OS, Syracuse 1, N. Y.*

Cutout Arresters . . .

This new line of cutout arrester combinations consists of an open-type distribution cutout mounted in conjunction with an externally gapped, valve-type arrester. Units are supplied for mounting on either crossarms or poles. Each mounting arrangement may be supplied with the arrester mounted vertically or horizontally. Any one of this manufacturer's five cutouts rated 7.8, 15, or 27 kv may be specified as components of these combinations. *Southern States, Inc., Hampton, Ga.*

Single-Conductor Cable . . .

High performance characteristics such as high strength, flexibility, low compression set, low water absorption, and excellent low temperature and abrasion properties are featured in a new 1-conductor buoyant cable. It uses an extruded natural polyethylene inner jacket over a high-strength center conductor. Two additional jackets of black foamed polyethylene give the cable a maximum of 0.76 specific gravity. Specification requirements include water testing at 600 psi. *International Silver Co., Times Wire & Cable Div., Wallingford, Conn.*

Line Voltage Regulator . . .

Characteristics and performance of voltage regulators is said to be improved greatly through use of a new regulator design. The new unit is a static-magnetic device to which has been added a sensing and control unit containing new semiconductor elements. The result is a compact unit which provides close regulation for line and load variations. Advantages of the new unit include: high input power factor with resistance load; frequency insensitivity; no voltage drift during warmup; ±1 per cent line regulation; and fail-safe performance. *Basic Products Corp., Milwaukee 1, Wis.*

Electric Demand Recorder . . .

An improved method of recording electric demand makes use of a pulse generator and a solid-state amplifier. The type M-1 unit does not have contacts or relays and is designed with high-reliability components. The equipment can be used with the same manufacturer's two- and three-stator meters and the digital demand recorder. Units are available that will deliver up to 100 pulses/minute. The demand recorder counts the pulses and provides maximum average demand readings on punched paper tape. *Sangamo Electric Co., Springfield, Ill.*

Ultrasonic Generator . . .

Many heavy-duty cleaning problems in industry can be solved through use of the model UG 1000 ultrasonic generator, according to the manufacturer. Output of the unit is 1,000 watts average. It includes a drift-free master oscillator and a power amplifier circuit permitting full output on 1-volt input. Used with an 11-gallon tank, the generator is capable of providing a power-to-capacity ratio of 91 watts per gallon. *Ultrasonic Systems, Inc., 2255 S. Carmelina Ave., Los Angeles 64, Calif.*

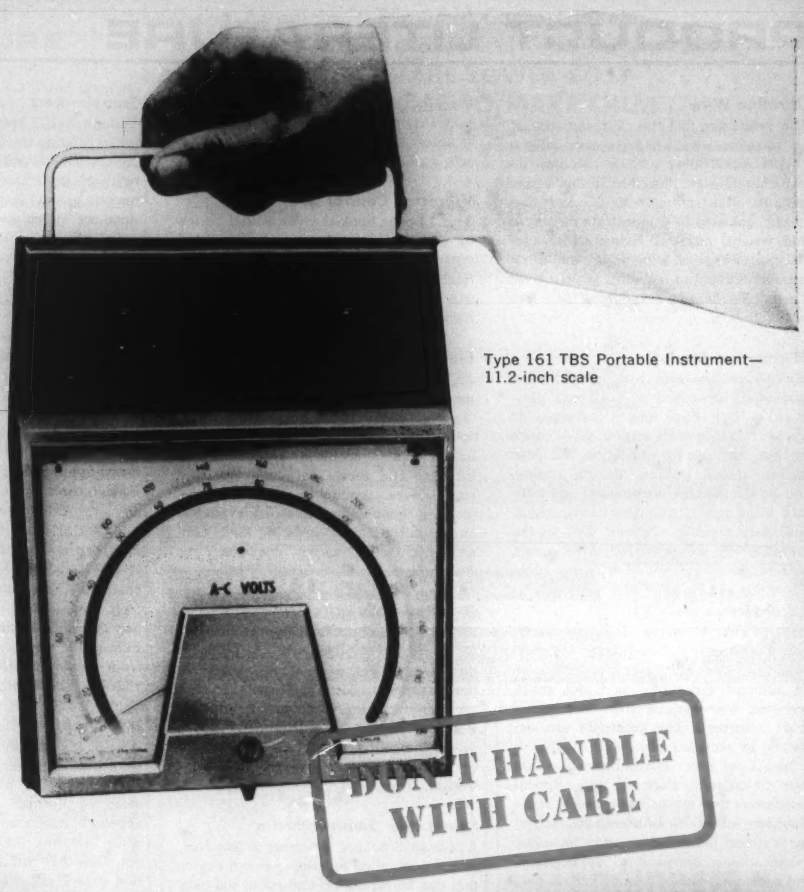
Distribution Transformers . . .

Available in introductory sizes, late this year, a new line of distribution transformers is designed for operation at 65 C rise. Pole Star 65 transformers will incorporate heat-stable TherMEcel insulation, a development of the Thomas A. Edison Research Laboratory. The manufacturer reports that extensive testing of prototype models has demonstrated low losses, low exciting current, low impedance, high overload capacity, and high short-circuit strength. Accelerated life tests have proved that the new insulation possesses exceptional retention ability of all necessary characteristics when subjected to high temperatures for extended periods. *Pennsylvania Transformer Div., McGraw-Edison Co., P. O. Box 330, Canonsburg, Pa.*

Voltage Regulator . . .

A 2½-kva self-contained automatic voltage regulator called UNOREG is now

available. It is designed for pole mounting on the low-voltage side of over 600 standard distribution transformer styles up through 50 kva. The regulator provides ±5 per cent regulation of 120/240-volt secondary lines. The two major areas of application for the device are: bucking the raised secondary voltage of individual distribution transformers located at the head end of a feeder; and boosting the secondary voltage of individual distribution transformers which are located at or near the end of a long or heavily loaded feeder. *Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.*



Type 161 TBS Portable Instrument—
11.2-inch scale

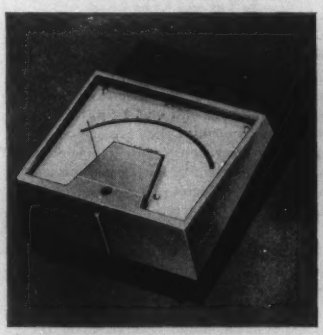
New, rugged Westinghouse portable instruments give long-term accuracy never before possible

There's no need to treat them gently. These new Westinghouse portable instruments have neither pivots nor jewels. There is no friction in the movement—no wear—nothing to get out of adjustment. The secret is a unique development—Westinghouse Taut Band Suspension. The moving element is suspended between strong metal bands under high tension. These bands carry the current to the coil and provide torsion against rotation.

In the Westinghouse instrument laboratory, this rugged instrument movement has withstood over 200 shock tests of 2400 G's and retained accuracy within ½%. After 24 million full-scale deflections, repeatability remained within 1/20 of 1%. By contrast, pivot and jewel instruments, after only one million deflections, will have so much friction their accuracy will be questionable. Conclusion: Westinghouse *tbt** portable instruments are the toughest precision portables ever made. Maintenance, recalibration and other adjustments are practically eliminated.

Westinghouse TBS portable instruments are available as a-c or d-c ammeters or voltmeters, with single or multi-range scales for practically any precision applications. Full-scale deflection as low as 1 microampere is available. Shatterproof glass window, high impact molded case and insulated retractable handle are standard features. Accuracy rating is ½% or ¼%. All Westinghouse portable instruments meet or exceed the requirements of ASA standard C-39.1. Write for complete specifications and a sample of Taut Band Suspension. Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. *You can be sure . . . if it's Westinghouse.* J-40541

*Trademark of Westinghouse Taut Band Suspension Instruments



Type 151 TBS Portable Instrument—
6.0-inch scale

Westinghouse

PRODUCT LITERATURE

Ultrafine Wire . . .

The properties and the characteristics of an ultrafine wire which is essentially a copper/nickel alloy used in precision instrumentation are described in this 4-page bulletin. Illustrations, charts, and diagrams, are used to demonstrate resistance and weight, physical characteristics, resistance change vs. temperature and other details pertinent to the wire. *Molecu Wire Corp., Eastontown-Freehold Pike, Scobeyville, N. J.*

Microwave Products . . .

Microwave products for modern electronics are described in a 42-page illustrated catalog. Each item is accompanied by an ordering information guide, with recommendations for utilization. A 2-page picture spread outlines design, testing, and production for commercial and military electronics, communications, radar, and space research. *Telerad, Div. of the Lionel Corp., Route 69-202, Flemington, N. J.*

Recorders . . .

GEA-6933A, 12 pages, describes direct- and servo-operated, switchboard and portable recorders, and relates information on 19 different types of single and multipen, ink and inkless, strip and round chart recorders. The recorders are described in accuracy classes of ¼, $\frac{3}{10}$, 1, 2, and 3 per cent. The bulletin also lists over 40 different electrical and physical parameters that can be measured by these recorders in various utility and industrial applications. Other information includes: specifications, dimensions, applications, and operating data. *General Electric Co., Schenectady 5, N. Y.*

Microphones . . .

Ultrasonic receiving or transmitting microphones utilizing piezoelectric barium titanate free edge transducers as used in the remote control of slide projectors, air conditions, television, lights, garage-door openers, and alarm systems are described in a 4-page booklet available from *Erie Resistor Corp., 644 W. 12 St., Erie, Pa.*

Electro-Optical Systems . . .

"Facilities and Capabilities" is a 28-page brochure containing information on design, manufacture, and use of electro-optical systems. Major sections cover reconnaissance and mapping systems; data processing, display and interpretation systems; communication and special radar systems; electronic control and ground support equipment; optics; ordnance products; service engineering; research and development; quality control, reliability and environmental test; and manufacturing. Copies are available from the *Marketing Manager, Defense Products Division, Fairchild Camera and Instrument Corp., 300 Robbins Lane, Syosett, L. I., N. Y.*

Vibration Control . . .

This 14-page booklet gives a brief review of vibration control. Sections cover history, principle, development, present function, and projected uses for vibration control using bonded rubber devices. *Advertising Dept., Lord Mfg. Co., Erie, Pa.*

Electric Data Sheets . . .

25 pages of catalog data sheets describe metallic, helically formed products, including armor rods and lineguards, splices, and lashing rods. Plastic products include treeguards, moldings, and tubings. The sheets list conductor and strand sizes, product lengths, strengths, weights, metals, and plastics available, and specification and ordering data. *Fanner Mfg. Co., Electrical Products Div., Brookside Park, Cleveland 9, Ohio.*

D-C Power Supplies . . .

A 56-page guide to semiconductor power rectifiers describes a-c and d-c applications, including anodizing, aircraft ground power supplies, battery chargers, capacitor manufacturing, and current limiting. Requests should be on company letterhead, indicating whether electroplating or industrial power supplies literature is wanted. *The Meaker Co., Nutley, N. J.*

Four-Layer Semiconductor . . .

A 4-page brochure describes a low-cost, germanium, alloy junction p-n–p-n device that can be turned on and off at the base in 0.1 microsecond and can switch in the megacycle range. The brochure describes the theory of operation of the device, and the properties which can be exploited by the circuit designer. Complete electrical and physical specifications on the semiconductor are given. Free copies are available upon request to *Tung-Sol Electric, Inc., 1 Summer Ave., Newark 4, N. J.*

Adjustable-Speed Drives . . .

A 32-page bulletin, no. GEA-6999, gives information to aid in analyzing and selecting adjustable-speed drives. The new brochure also deals with product description and application, factors in drive selection, and examples of and recommendations for special applications. A price-comparison table, reflecting typical drive price curves plotted against drive horsepower, enables the reader to consider cost in selecting from various drives. Copies of the bulletin may be obtained from the *General Electric Co., Schenectady 5, N. Y.*

Transformers . . .

Bulletin 61202 covers information on a self-regulating transformer. It explains the connection versatility and location flexibility of the transformer, and illustrates operating and design features. Ordering data are systematically listed. *Line Material Industries, 700 N. Michigan, Milwaukee 1, Wis.*

Capacitors . . .

A line of glass, plastic, and ceramic capacitors is described in a new 16-page bulletin, 314-3. The feature of the booklet is glass trimmer capacitors, which operate from −55 C to +125 C at 1,000 working volts d-c and are available in panel mount for conventional point-to-point wiring or printed circuit mount for board applications. *Erie Electronics Div., Erie Resistor Corp., 644 W. 12 St., Erie, Pa.*

Electronic Controls . . .

Automatic transfer switches, magnetic contactors, special electromagnetic controls, and timing devices are illustrated and described in this 4-page file bulletin. For a free copy, request Bulletin A-17 from *Zenith Electric Co., Dept. EE-2, 152 W. Walton St., Chicago 10, Ill.*

D-C Amplifier . . .

A 4-page bulletin describes a reliable solid-state amplifier. A circuit concept involving the use of semiopen loops instead of the conventional closed loop approach, makes internal filtering possible while isolating the input from the output. The bulletin includes three operation curves as well as specifications and application data. *Neff Instrument Co., 1088 E. Hamilton Rd., Duarte, Calif.*

Electrostatic Generators . . .

An 8-page brochure describes a line of electrostatic generators used in nuclear physics, insulation testing, electron microscopy and optics, X-ray generation, electrostatic precipitation, etc. Specifications given for these high-voltage d-c power supplies cover models ranging from 50 to 600 kv output. Features, applications, and principles of operation are included. A series of schematics illustrate the test. *SAMES-USA, 30 Broad St., New York 4, N. Y.*

Fluorosilicones . . .

Three technical bulletins on fluorosilicone fluids, greases, and compounds, respectively, contain properties and performance charts and graphs, and suggested applications for these solvent, fuel, and chemical-resistant materials. The bulletins, designated 15-200 for fluid, 15-201

(*Continued on page 25A*)

PRODUCT LITERATURE

(*Continued from page 24A*)

for compounds, and 15-202 for greases, are available without charge from *Dow Corning Corp., Midland, Mich.*

Data Processing . . .

"IDP Products in Action" presents 32 pages of systems applications involving tape-operated business machines. Illustrations and explanations eliminate the need to understand the complexities of systems work. Machines are shown handling order–invoice, data collection, MICR check, and insurance procedures, etc. *Promotion Planning Dept., Friden, Inc., 97 Humboldt St., Rochester 2, N. Y.*

Cable Analysis . . .

A 4-page technical bulletin, "Non-Destructive Inspection of Cable Terminations and Splices by X-Ray Analysis," describes the procedures of radiographic inspection employed in examining electrical cable terminations and splices by the use of X ray. Illustrations include photographs made with the use of actual test X rays. Request Technical Bulletin no. 7 from *Balteau Electric Corp., 10-14 Meadow St., Stamford, Conn.*

Power Supplies . . .

This 44-page catalog covers a line of standard and custom-engineered power supplies, ranging in size from 50 watts to 5,000 kw. Features include a glossary covering terms used most frequently in power supplies, a basic power supply and control feature evaluation chart, an electroplating guide, information in rectifier circuits, suggested applications for various units, and diagrams. Write on letterhead to *American Rectifier Corp., 95 Lafayette St., New York, N. Y.*

Electronic Devices . . .

This catalog describes missile ground support equipment, electronic testing gear and devices for automating production machinery, and office equipment. It is available upon written request on company letterhead, from *C. B. Dick, Kidde Aero-Space Div., Belleville 9, N. J.*

Furnace Explosions . . .

Furnace explosions are the subject of a 16-page bulletin analyzing the causes of 156 recent explosions. The theory of explosions during flameouts is discussed and recommendations for safe operating procedures are presented. Copies of Bulletin E-101 may be obtained from *The Babcock & Wilcox Co., Advertising Dept., 161 East 42 St., New York 17, N. Y.*

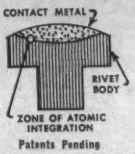
Heaters . . .

A new catalog contains specification data on three styles of small-capacity steam and hot-water unit heaters, ranging in

(*Continued on page 28A*)

Gibson Atomiclad* Electrical Contact Rivets now available in economical Gibson Assemblies

ATOMICLAD RIVETS ARE LOWER COST BECAUSE IT COSTS LESS TO MAKE THEM



Patents Pending

And they're BETTER because their bond of dispersed atoms of the precious contact metal and the base metal of the body is electrically and mechanically superior to other bonding methods. Cost is further reduced by limiting use of precious metal to electrical requirements of the contact.

Atomiclad Rivets are made in all standard forms and of copper, steel or other base metal with contact face of precious or semi-precious metals.

Many sizes and types are stocked in quantity. Write for Standard Stock List #2007, and for Technical Information Bulletin 400.

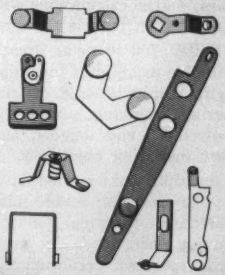
ECONOMICAL GIBSON CONTACT ASSEMBLIES

Gibson contact support manufacturing facilities include every phase—forming, riveting, heat-treatment and electroplating and comprises use of any specified metal.

When you specify Gibson Contact Assemblies, you get the benefit of years of engineering know-how in providing the best possible electrical union between contact and support member. Since all assemblies are Gibson-inspected, the customer suffers no loss through assembly rejects.

Gibson Engineers will design your complete contact assembly upon receipt of specifications. Or send your drawings for fabrication costs. If you prefer your own support member, send a sample for assembly cost.

*ATOMICLAD—Trademark Gibson Electric Company



GIBSON ELECTRIC SALES CORP.
BOX 588 DELMONT, PA.
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Power and Industrial Division offers immediate employment opportunities for electrical, mechanical, or structural engineers capable of assuming responsibility on design of major steam or hydro power plants.

Relocation allowances cover moving costs plus transportation reimbursement for you and members of your family. If you have an interest in a San Francisco assignment, please send a resume of experience to W. A. Anderson, Technical Recruiting. Personal interviews will be arranged for qualified candidates.

Bechtel
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San Francisco, Calif.

In New York City, a personal interview can be arranged by phoning Edmund J. Orr, MUrray Hill 7-7100.

Electrical Engineers

Opportunities for research and development in areas of semiconductors, plasmas, and ferromagnetic materials. Experience and/or advanced degree desirable. For further information write, briefly stating your background and experience, to

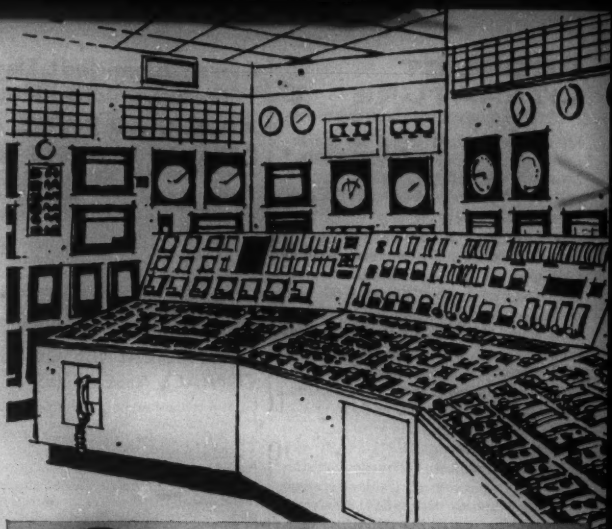
Mr. J. T. Jarman
Research Division
Allis-Chalmers Manufacturing Company
Milwaukee, Wisconsin

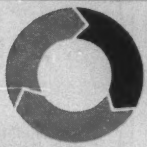
FIRST SIMPLIFY...

First step to automation is to *simplify* the information now presented by a multitude of multi-record charts, gages, and annunciator lights. The Bailey approach gives the operator data he needs (logged periodically), keeps continuous watch on all variables, makes calculations where required, alarms when trouble threatens.

Bailey 700 Systems draw on the best available techniques, including analog and digital manipulation, trend recording, time sharing, scanning, alarming, calculating, controlling, and logging, as required to meet operating objectives.

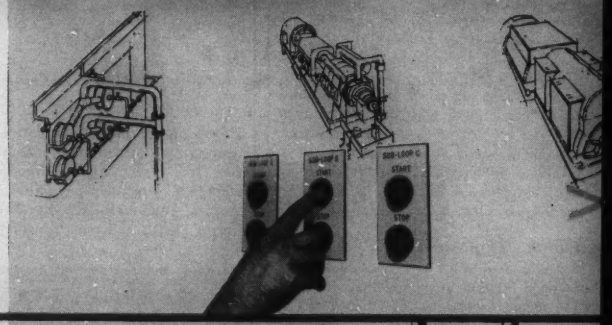
Reliability of recorded data is increased ... operators can devote full attention to correcting off-normal conditions and improving operations. The system may include frequent performance calculations showing the contributions of each portion of the cycle to over-all performance so that faults and deterioration may be spotted and corrected.

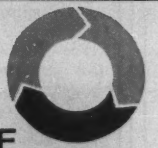




NEXT VERIFY...

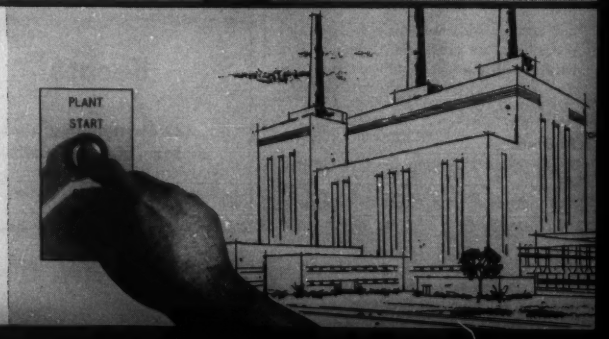
Next verify the practicability of automation by extending supervisory controls, letting equipment perform more operating functions. Automate key systems, one at a time, by push-button-controlled subloops. This approach smooths the transition to complete automation.





THEN AUTOMATE

Final steps are: (1) consolidate supervisory controls, conventional controls, and subloops for full-range automatic operation once the plant has been placed on the line; and (2) add start-stop control to provide full automation.



first Simplify...

NEXT VERIFY...
THEN AUTOMATE

Bailey verified steps to automation mean benefits now... and increasing benefits as you go

Automation need not be an all-out commitment. Between today's conventional power-station control and the ultimate in automation are step-by-step advantages that can be gained—as individual problems are resolved.

This permits the final investment commitment only after satisfactory evidence that it is economically justified and practicable.

Bailey Systems concepts are embodied in the approach, "First simplify — next verify — then automate". The steps outlined here coordinate the best available techniques, including analog and digital, in Bailey 700 Systems designed — and expanded as desired — to the needs of the individual plant. They may be undertaken singly, in combination, or in entirety. System elements are composed of solid-state electronic modules providing the ultimate in reliability and flexibility.

Bailey 700 Systems are in operation today —or on order for installation—from coast to coast and all over the world. Ask your Bailey Engineer, or write for details. Bailey Meter Company, 1069 Ivanhoe Road, Cleveland 10, Ohio. In Canada — Bailey Meter Company Limited, Montreal.

System concepts founded on 45 years of experience

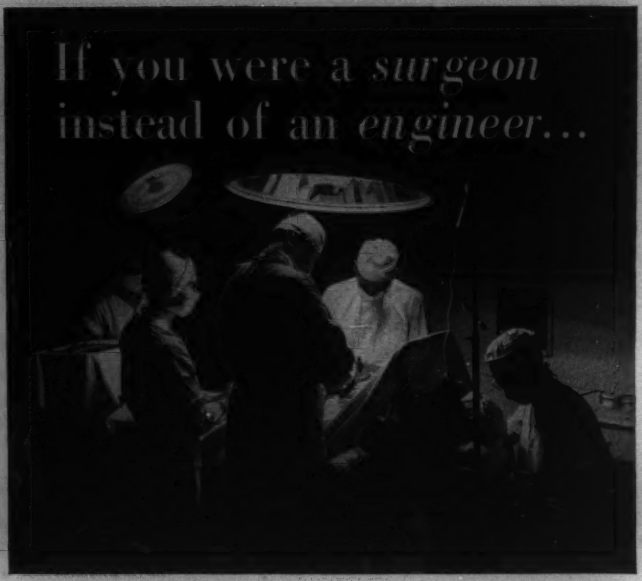
21 out of 26 of today's "most efficient" steam-electric stations in the United States use Bailey Instruments and Controls*. This reflects the more than 45 years of Bailey developments devoted to improving the reliability of power-plant operation. These developments include experience in automation, dating from electrically operated boiler controls in 1924 and automatic start of boiler controls on steam-electric locomotives in 1936, to systems installations in operation, or under construction today, from coast to coast and throughout the world.

**Listed in Federal Power Commission Report S-143.*

A 166-2

BAILEY METER COMPANY

700 Systems



. . . you'd want to work at one of the *leading* hospitals in the nation—where your associates would represent the finest medical talents available. In such a situation you could grow more in a year than in a lifetime spent in an ordinary clinic.

The same thing is true of every profession. Your own stature as an engineer is determined to a great extent by the calibre of your associates.

At Motorola you will be working for and with some of the most respected engineers and scientists in the electronics field—Motorola is an "engineer's company." And, here at Motorola the horizon is wide and the ceiling unlimited—you can go as far—*as fast*—as your capabilities permit. You'll be working for a *secure*, diversified company—not wholly dependent on one single market.

You owe it to yourself and your family to investigate the opportunities at Motorola. Dozens of fields of interest are open—just a few of which are listed below. Write today for the full story.

We'll send you a complete description of "Your Life at Motorola"—in Chicago; Phoenix; Riverside, California; Culver City, California; Minneapolis, Minnesota. Naturally your request will be kept in complete confidence.

- Radar transmitters and receivers
- Radar circuit design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using kylstrom, traveling wave tube and backward wave oscillator
- Display and storage devices

2-WAY RADIO COMMUNICATIONS
- VHF & UHF receiver
- Transmitter design and development
- Power supply
- Systems engineering
- Antenna design
- Selective signaling
- Transistor applications
- Crystal engineering
- Sales engineering

- Design of VHF & UHF FM communications in portable or subminiature development
- Microwave field engineers
- Transistor switching circuit design
- Logic circuit design
- T.V. circuit design engineering
- Home radio design
- New product design
- Auto radio design
- Mechanical engineering
- Semi-conductor device development
- Semi-conductor application work

MR. W. H. HAUSMANN
Engineering Personnel Mgr. Dept. A
4545 Augusta Blvd., Chicago 51, Ill.

All qualified applicants will receive consideration for employment without regard for race, creed, color, or national origin.

MOTOROLA inc.

PRODUCT LITERATURE

(*Continued from page 25A*)

capacity from 13,400 to 1,062,000 Btu per hour. Information includes steam and hot-water ratings, physical dimensions, and electrical and piping diagrams. The 20-page catalog is available from *Carrier Air Conditioning Co., Syracuse, N. Y.*

Graphite Properties . . .

A new edition of the bulletin "Graphite for Rectifiers and Power Tubes" provides detailed information on properties of graphite, design hints for anodes, and a table of recommended graphite grades for anodes and related parts. The brochure is available on request to *Carbon Products Div., Speer Carbon Co., St. Marys, Pa.*

Dielectric Testing . . .

A reprint is offered of excerpts from the transcript of a technical seminar held on the west coast, to clarify some of the confusion and disagreement regarding dielectric testing. Write for Bulletin 10-15.1, "High Potential Dielectric Testing," *Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.*

Test Equipment . . .

A 4-page bulletin on high-voltage test sets features a new line of high-voltage a-c test sets including a series of high-capacity units with elaborate control circuits for maximum convenience and safety, for testing in accordance with ASTM standards. *Peschel Electronics, Inc., Patterson, N. Y.*

Security Systems . . .

The first of a series of product information sheets on security has been released. The first three cover audio detection and taut wire systems. The information sheets detail these products, explain how they work, and describe component parts. The series will also discuss typical installations. *Minneapolis-Honeywell, Commercial Div., 2753 Fourth Ave., South, Minneapolis 8, Minn.*

MicroSADIC . . .

A 16-page brochure, Bulletin 3047, describes a digital data acquisition system. The brochure provides a technical introduction to the system, presents a brief functional description of all of the system's major components, and includes detailed system specifications. A copy of the brochure may be obtained by writing *Consolidated Systems Corp., 1500 S. Shamrock Ave., Monrovia, Calif.*

Mica Capacitors . . .

An 18-page bulletin describing 90 variations of resin-sealed button-mica capacitors is now available from *Erie Electronics Div., Erie Resistor Corp., 645 W. 12th St., Erie Pa.*

INDUSTRIAL NOTES

Swedish Hydro Plant Built At Cost Of $33 Million

Sweden's steel, forest, and mining industry group known as Stora has inaugurated a new 300-mw hydro-power plant situated on the Österdalälven River. The new plant facility includes a rock-fill power dam 400 feet high. The plant will increase Stora's electric power output by

50 per cent. Machinery used in the plant consists of two Francis turbines of 140,000 hp each from Karlstads Mekaniska Werkstad, and also Asea generators and transformers.

The decision to use rock fill instead of concrete was made mainly for military reasons. A dam of the rock-fill type is claimed to resist even atom bombs. Since construction of the power plant was begun in 1955, 1,500 tons of dynamite and 30,000 tons of cement were used.

During the past 15 years, Stora's energy consumption has risen by 250 per cent while, at the same time, Sweden's over-all power consumption was up by about 170 per cent.

Transformer Plant Opened By New Manufacturer In Field

The Petersburg Transformer Corp., a new transformer manufacturing organization, has begun operations in a modern plant in Petersburg, Pa. The firm is a wholly owned subsidiary of Tresco, Inc., and will manufacture transformers on long production runs. The half-million dollar plant is located on a 7-acre site and at full capacity will employ 300 people.

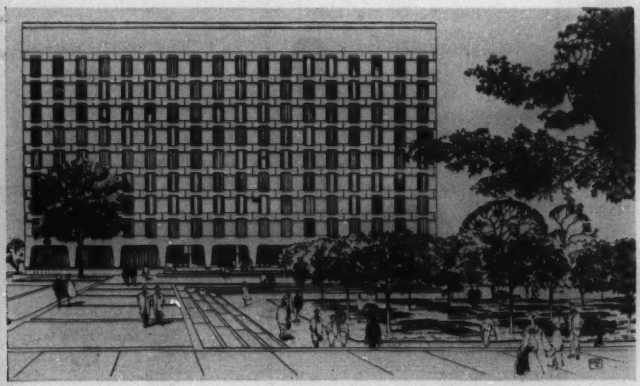
New Firm Specializes In High-Vacuum Equipment

Design and manufacture of high-vacuum evaporating equipment for the electronics industry is the specialty of Vacuum Equipment and Components Div. of Suburban Plastics Co. The equipment is of the type used for the thermal deposition of thin films on components such as precision resistors, vacuum paper capacitors, and microwave attenuator plates. It is also used for crystal plating and production of glass-to-metal seals.

C-E-I-R Computing Center To Be World's Largest Facility

Groundbreaking ceremonies for the world's largest and most powerful electronic computing center took place recently at Cambridge, Mass. C-E-I-R, Inc., will install and operate a $15 million facility in Technology Square, shown by an artist's rendering in the accompanying illustration. The computer center will be equipped with a Stretch computer and is expected to be in full-scale operation in 1963. Facilities will be available to business and industrial organizations as well as other users.

The Stretch computer, manufactured by International Business Machines Corp., is able to perform more than 30 billion multiplications during a 24-hour period; a 14-digit number, for example, can be multiplied by itself in 2.7 millionths of a second.



New Contract Awards Cover Varied Fields of Interest

Sparton Electronics, a division of Sparton Corp., has been awarded military electronics contracts totalling $14,500,000 by the U. S. Department of the Navy for various types of Sonobuoys, devices used in anti-submarine warfare. . . . *Vitro Laboratories*, New York, N. Y., has been awarded a $585,000 contract by the U. S. Navy's Bureau of Naval Weapons for the continuation of engineering services on one of its most modern torpedo weapons systems now in service. . . . Notice of a multi-million dollar contract for the manufacture of two F-104J Flight Simulators has been received by *Link Division, General Precision Inc.*, Binghamton, N. Y., and Palo Alto, Calif. Link announced that the Japan Defense Agency has signed a letter of intent with Mitsubishi Electric Co., Tokyo, with whom General Precision has a licensing agreement. . . . The Armament Division of the *Universal Match Corp.* has received a $2.1 million contract from the Army Ballistic Missile Agency for quantities of Transporter-Erector-Launchers for the Pershing Missile.

New Facilities Aid Research and Production

Burndy Corp., Norwalk, Conn., has opened a new 25,000-square-foot plant in Malines, Belgium, for its wholly-owned Belgium subsidiary, Burndy Electra S. A. Connectors manufactured in the new plant will be marketed through sales subsidiaries in West Germany, Switzerland, France, and Italy and through sales representatives in Belgium, Holland, Denmark, Sweden, and Austria. . . . *General Electric Co.* has opened a new laboratory for the testing of its industrial and aircraft true mass flowmeters. The new facility is located at the company's Instrument Dept. in West Lynn, Mass. . . . *San Diego Gas and Electric Co.* has announced its intent to participate with *Southern California Edison Co.* in the procurement and operation of an automated, nuclear-fueled, steam-electric generating station to be located on a site about midway between the Los Angeles and San Diego load centers. The site preparation and development will be

(*Continued on page 40A*)

Contamination defeated!

One-piece porcelain excludes destructive leakage current from arrester's protective circuit

Contamination has always posed a destructive threat to the life of a stacked lightning arrester, but the Thorex one-piece porcelain housing defeats all attempts of contamination to interject serious voltage unbalance at inter-unit connections. There are no such connections of Thorex Station Class arresters - - just a solid one-inch thick continuous porcelain wall from top to bottom.

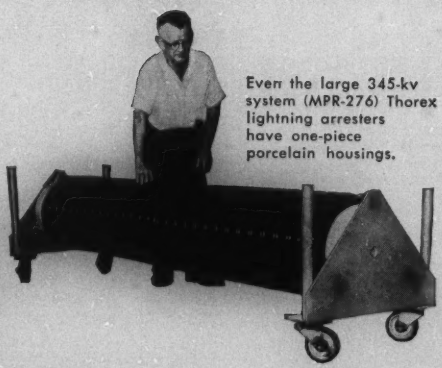
Can we prove its effectiveness? Look for yourself . . . we super contaminated this 138-kv system Thorex lightning arrester. Over and under each petticoat we sprayed salt solution, let it dry, and then showered the arrester with water and a wetting agent while we energized the arrester at rated voltage. *The resulting external flashover had no adverse effect on the arrester's internal protective circuit.*

We chose to apply an extremely severe test. A stacked arrester would have failed long before leakage currents reach flash-over level, but the Thorex one-piece porcelain housing keeps leakage currents on the outside to bleed harmlessly to ground.

How about washing this arrester while it is energized? You can wash it just as readily as any other piece of station insulation.

Thorex Station Class arresters not only offer the most effective means of eliminating arrester loss due to contamination but also give the lowest IR discharge voltage, quickest extinction of 60 cycle follow-current, best long duration thermal durability and most convenience in installation. You can have all this at no extra cost.

OHIO BRASS COMPANY, MANSFIELD, OHIO



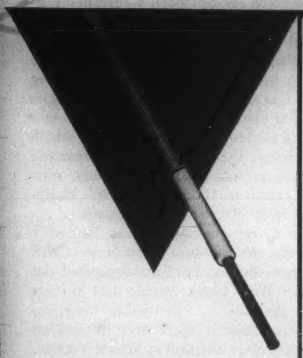
Even the large 345-kv system (MPR-276) Thorex lightning arresters have one-piece porcelain housings.

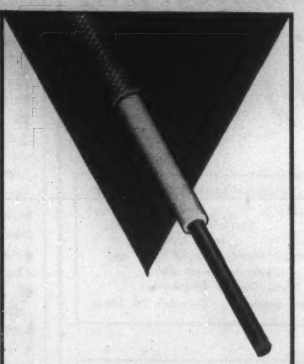
Ohio Brass HOLAN

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
BUSHINGS • HOLAN TRUCK-MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

10103-H

Wire & Cable Selector





APPARATUS and MOTOR LEAD WIRE	LIGHTING WIRE
600 volt	600 volt
200°C	125°C
#20 to 4/0 AWG	#14 to #8 AWG
Conductor — Tinned copper, stranded **Insulation** — Silicone rubber **Covering** — Glass braid	**Conductor** — Solid tinned copper **Insulation** — Silicone rubber **Covering** — Glass braid
For leads to motors and transformers in high temperature locations. Stands up excellently under varnish dip and bake processes.	For lighting circuits in high ambient temperature locations.

Rockbestos Silicone rubber cables give you these outstanding advantages:

- excellent heat resistance 125°C-200°C allowable conductor temperature
- flame resistant—slowly forms non-conducting ash maintaining circuit integrity
- corona and ozone resistant
- maintains flexibility from —130°F to +500°F
- excellent resistance to oil, solvents, fuels and chemicals
- excellent electrical properties

ROCKBESTOS WIRE AND CABLE CO.
division of CERRO CORPORATION
Nicoll and Canner Sts., New Haven, Conn.

Gentlemen:

I would like to know more about the unique advantages of Rockbestos Silicone Rubber Wire and Cable. Please send me the following:

- ☐ The Rockbestos Silicone Wire & Cable Catalog.
- ☐ A sample of your silicone rubber wire.
- ☐ Please have distributor or salesman call.

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Company_____

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River Basin Development
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Pioneer Service & Engineering Co.
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Purchasing—Construction Management
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DIRECTORY
when in need of specialized
engineering service

INDUSTRIAL NOTES

(*Continued from page 31A*)

undertaken by Southern California Edison at a cost of about $9.6 million. The power plant contract cost will be $68,557,000. . . . *Amphenol-Borg Electronics Corp.*, has dedicated a new plant at the Fair Lawn, N. J., Industrial Park. It is the first plant of the newly created Amphenol-Eastern Connector Div., which will design and produce wire connecting devices, principally for computers, missiles, aircraft, communications equipment, and electronic instruments. . . *Radio Corp. of America* has formed a data systems division in Van Nuys, Calif. The new division has been organized out of the West Coast missile and surface radar division. . . . *Instru-Lec Corp.* recently completed machinery installation in a new plant addition at Mount Vernon, N. Y. The new facility accommodates an increase in engineering, assembly, and test areas. . . . *Multi-Amp Electronic Corp.* announces that its new headquarters and plant in Cranford, N. J., are now in operation. They are housed in a 15,400-square-foot building on a two-acre site. . . . *Prest-O-Lite Battery Co., Ltd.*, has completed a new battery manufacturing plant in Drummondville, Quebec.

Information Service Designed to Aid Industry

The Technical Library of The Franklin Institute in Philadelphia has set up a special Science Information Service designed to aid industry and scientific institutions in implementing research and development projects. The service offers literature searches in any area of mathematics, engineering, physics, chemistry and industrial processing. It includes bibliographic compilations (author-title-source), annotated bibliographies, abstracts of articles on a regular basis, current literature monitoring on any subject, and translations.

Raytheon Purchases Assets Of Rheem Semiconductor Corp.

Raytheon Co. has announced that it has reached agreement in principle to purchase substantially all of the assets of Rheem Semiconductor Corp., a subsidiary of Rheem Manufacturing Co., at Mountain View, Calif. The 100,000 square-foot leased plant is located on a 20-acre site in a large industrial park adjacent to Moffett Air Force Base and 35 miles south of San Francisco. According to Raytheon, the technical depth and scientific strength of Rheem Semiconductor as evidenced by the advanced semiconductor products developed and introduced was a major attraction in the proposed acquisition.